OT Technical Memorandum 76-221

# A GUIDE TO TECHNICAL STANDARDS AND MEASUREMENTS FOR CABLE TELEVISION SYSTEMS



OT

U.S. DEPARTMENT OF COMMERCE Office of Telecommunications

OT Technical Memorandum 76-221

# A GUIDE TO TECHNICAL STANDARDS AND MEASUREMENTS FOR CABLE TELEVISION SYSTEMS

WILLIAM C. HSIAO

U.S. DEPARTMENT OF COMMERCE
ELLIOT L. RICHARDSON, Secretary

BETSY ANCKER-JOHNSON, Ph.D.
Assistant Secretary for Science
and Technology

OFFICE OF TELECOMMUNICATIONS
JOHN M. RICHARDSON
Acting Director

July 1976

## UNITED STATES DEPARTMENT OF COMMERCE
## OFFICE OF TELECOMMUNICATIONS
## STATEMENT OF MISSION

The mission of the Office of Telecommunications in the Department of Commerce is to assist the Department in fostering, serving, and promoting the nation's economic development and technological advancement by improving man's comprehension of telecommunication science and by assuring effective use and growth of the nation's telecommunication resources.

In carrying out this mission, the Office

- Conducts research needed in the evaluation and development of policy as required by the Department of Commerce
- Assists other government agencies in the use of telecommunications
- Conducts research, engineering, and analysis in the general field of telecommunication science to meet government needs
- Acquires, analyzes, synthesizes, and disseminates information for the efficient use of the nation's telecommunication resources.
- Performs analysis, engineering, and related administrative functions responsive to the needs of the Director of the Office of Telecommunications Policy, Executive Office of the President, in the performance of his responsibilities for the management of the radio spectrum
- Conducts research needed in the evaluation and development of telecommunication policy as required by the Office of Telecommunications Policy, pursuant to Executive Order 11556

# ACKNOWLEDGEMENTS

The author wishes to thank the following people for their encouragement prior to and their help during the preparation of this report: Robert C. Powell of the Office of Telecommunications, U.S. Department of Commerce, Robert S. Powers of the Federal Communications Commission, Allen Shinn of the National Science Foundation, and Delmer Ports of the National Cable Television Association.

Preparation of this memorandum was supported in part by the Research Applied to National Needs program of the National Science Foundation, under grant No. SSH74-24664.

This work is being published as a Technical Memorandum recognizing that the results are preliminary and for a limited audience. This work is being made available to other agencies planning to further develop standards and measurements for cable television.

## TABLE OF CONTENTS

## LIST OF FIGURES

# A GUIDE TO TECHNICAL STANDARDS AND MEASUREMENTS FOR CABLE TELEVISION SYSTEMS

William C. Hsiao*

## ABSTRACT

The preparation of this memorandum was supported in part by Grant No. SSH74-24664 from the National Science Foundation. The National Science Foundation awarded seven grants under Phase I of the program, "Design Studies for Experimental Application of Two-Way Cable Communications to Urban Social Service Delivery and Administration." The seven grantees provided to the Foundation on January 6, 1975, detailed final proposals for the execution of appropriate experiments in broadband communications. Under the NSF grant to the Office of Telecommunications, OT provided to the Foundation and the seven Phase I grantees technical advisory services, including draft versions of Sections 1 and 3 of this memorandum, to assure that the seven grantees had access to up-to-date technical information needed to adequately formulate and support their Phase II proposals.

Section 1 of the memorandum discusses CATV system technical requirements and lists referenced specifications, CATV system design criteria, system performance guidelines, and system construction specifications. Section 2 consists of ten measurement chapters which discuss test procedures applicable to measurement and evaluation of technical performance of CATV systems to assure compliance with the Federal Communications Commission's Rules and Regulations. Section 3 of the memorandum is a bibliography of technical literature concerned with cable television systems. The references have been organized into ten subject areas listed in the Table of Contents and consist of 807 entries.

*This work was done while the author was with the Office of Telecommunications, U.S. Department of Commerce, Washington, D.C. 20230.

# 1. CATV SYSTEM TECHNICAL REQUIREMENTS

## 1.1 Introduction

It is vital to plan, construct, test, and operate any CATV system to the highest level of technical standards permissible by economical constraints and achievable within the framework of current technology. To meet this objective, the following system design criteria, performance guidelines, and construction suggestions have been developed.

Deviations from these guidelines may be required due to local conditions to conform to specific needs, problems, codes, etc., of its community. Therefore, the recommendations should be considered a general guideline rather than an inflexible set of rules.

## 1.2 Definitions

The following definitions shall apply to terminology used in this guideline. Additional terms are defined in other portions of the guideline.

- Channel--Frequency spectrum of any information carrier.

- Distribution System--Any portion of the CATV system which contains cable, passive devices, hardware, or electronics which convey signals from the trunk cable to the subscriber drop cable.

- Trunk System--Any portion of the CATV system which contains cable, passive devices, hardware, or electronics which convey signals from the "head-end" to a distribution amplifier.

- Head-End--The electronic equipment located at the start of a cable system, usually including antennas, preamplifiers, heterodyne processing devices, frequency converters, modulators, demodulators, and other related equipment.

- Distribution Amplifier--Any amplifier used in the distribution system.

- Trunk Amplifier--Any amplifier used in the trunk system.

- Subscriber Drop--Output of subscriber tap-off device.

- Subscriber Drop Cable--Cable from subscriber drop to subscriber grounding block.

- Feeder Cable or Distribution Cable--Cable used in distribution system.

- Trunk Cable--Cable used in trunk system.

- Active Tap--A subscriber tap-off device which has active circuitry for providing amplification of signals to the subscriber drop.

- Set-top Converter--Electronic equipment used by each subscriber and placed before the television set which converts any or a block of the distributed television channels to a channel or channels on the television set.

## 1.3 Referenced Specifications

The following applicable documents are listed for reference.

- Federal Communications Commission (FCC) Rules and Regulations (R&R), Volume III, Parts 73 and 76.

- American National Standards Institute (ANSI) C1-1971.

- Electronic Industry Association (EIA) RS-170.

- National Cable Television Association (NCTA) Engineering Standards.

- National Electric Safety Code, National Bureau of Standards Handbook No. 130.

- Applicable Utility Joint Attachment Practices.

- City, County, and State Codes and Ordinances.

## 1.4 CATV System Design Criteria
(Refs. 231, 318, 402, 678, 680, 698, 707, 720)

I. Coaxial Cable (Refs. 231, 707)

A. The following coaxial cable or its equivalent shall be used in the distribution system:

1. 0.750 polyethylene foam cable with solid copper center conductor.

2. 0.500 polyethylene foam cable with solid copper center conductor.

3. 0.412 polyethylene foam cable with solid copper center conductor.

4. 0.750 polystyrene foam cable with copperclad aluminum center conductor.

B. These cables shall be of solid aluminum sheath for aerial plant. Underground cable installations shall be protected by a high density polyethylene jacket and a viscous flooding compound.

C. Trunk and distribution coaxial cables shall have the following characteristics:

1. Characteristic impedance of 75 ±2 ohms over the passband frequency range.

2. High structural return loss, nominally 26 dB minimum in the frequency passband.

3. Maximum attenuation at 70 degrees F as follows:

   a. 0.412" cable attenuation at 270 MHz = 1.87 dB/100 ft.

   b. 0.500" cable attenuation at 270 MHz = 1.48 dB/100 ft.

   c. 0.750" cable attenuation at 270 MHz = 1.10 dB/100 ft.

4. Maximum 60 Hz AC loop resistance at 70 degrees F as follows:

   a. 0.412" cable--loop resistance of 2.4 ohms/1000 ft.

   b. 0.500" cable--loop resistance of 1.5 ohms/1000 ft.

   c. 0.750" cable--loop resistance of 0.7 ohms/1000 ft.

D. Underground Cable--All underground cable shall adhere to the above specifications. In addition, where cable is installed in buried conduit, the cable shall contain an additional moisture barrier in the form of a flooding compound interspersed between the outer polyethylene jacket and the aluminum tubing. No trunk or distribution cable shall be directly buried unless it contains a protective steel outer covering (spiral wrap or corrugated), a second polyethylene jacket protecting the steel from corrosion, plus a moisture barrier flooding compound inside both the inner and outer jackets.

E. Subscriber Drop Cables--In the case of dual cable system, overhead drop cables should preferably be dual type to present a neat appearance. Underground installations may be separate cables. However, in either case, 100 percent shielded type cable is required. Where a dual drop is installed underground, it should either be in plastic conduit or a cable type specifically designed for direct burial for the soil conditions indigenous to the area. In any event, direct burial drop cables should be preferably a dual jacket type with steel

outer wrap and moisture protective flooding compound.

II. Head-End Equipment (Refs. 706, 720)

A. Antennas--Each antenna shall be of sufficient gain and directivity to provide adequate reserve of signal to noise ratio and suppression of adjacent channel interference. Co-channel interference levels shall be computed and each antenna selected and oriented for a theoretical minimum suppression of the undesired co-channel station. If necessary, the antenna height may be reduced to achieve required ratios. Except where specific needs dictate, all VHF antennas shall be of log periodic design. More than one station may be received on an individual antenna, providing all specifications can be achieved, including co-channel suppression. The following specifications shall apply:

1. Antennas shall be ruggedized in construction with heavy duty cross arms and welded joints.

2. All exposed metallic parts shall be adequately protected from corrosion.

B. Converters and Preamplifiers--All active tower mounted devices shall be designed to operate continuously and meet full specifications under the most adverse weather and temperature conditions anticipated. Converters shall be frequency stabilized to conform to $\pm 25$ kHz tolerance.

C. Heterodyne Processing Devices--All processing amplifiers shall be solid state and of modular design. The following nominal specifications are given as a guideline.

1. Response: $\pm 1$ dB maximum over desired channel.

2. Sensitivity: -20 dBmV input level for +55 dBmV output.

3. Adjacent Carrier Rejection: 50 dB.

4. Image Rejection: 60 dB.

5. Output Level: Adjustable to +55 dBmV.

6. AGC Range: +0.5 dB output level variation for input levels of -20 dBmV to +20 dBmV.

7. Ambient Temperature Range: -20 degrees F to +100 degrees F.

8. Frequency Stability:

   a. On channel: phase locked to TV station.

   b. Off channel: ±25 kHz of assigned frequency.

D. Combining Network--The single channel head-end processing amplifier outputs shall be combined in a network which will result in maximum isolation between channels. The network should be designed so that a correct impedance match to each signal processed is maintained regardless of the condition of other processors in the system. High return loss, nominally 18 dB minimum, is desirable at all times at any input and output port of the network.

III. Trunk and Distribution Equipment (Refs. 231, 707)

A. Equipment performance shall be such as to ensure that all specified system performance standards will be equaled or exceeded.

B. All active circuitry in the equipment shall be transistorized.

C. Lightning protectors shall be used in all active equipment to prevent damage due to induced lightning surges.

D. All equipment shall be protected from accidental damage that could result from either short circuits or overvoltage. This protection shall be by fuses, circuit breakers, or other electrical devices.

E. Outdoor equipments, except for AC power supplies, shall be housed in weatherproof, rugged, cast aluminum housing which are fully protected against corrosive elements of the region's atmosphere.

F. All equipment shall be AC powered by a 60 Hz waveform nominally 30 or 60 volts rms. This AC voltage could be multiplexed on the coaxial cable

or be brought directly into the trunk amplifier. AC power insertion will be made in a manner such that high isolation, nominally 50 dB, shall exist between the RF path and AC insertion point.

G. Remote power supplies for powering of electronic equipment shall be ferro-resonant regulating, such that the AC voltage does not vary by more than $\pm 2\%$ with an input voltage of 90 to 130 VAC.

H. All active equipments (other than active taps) shall contain provision for directing AC power through the cable, selecting it from either an input and output port or directing it to either an input or output port.

I. Test points shall be provided at inputs and outputs of trunk amplifiers and distribution amplifiers.

IV. Passive Devices (Refs. 707, 720)

A. All passive equipment should be capable of having frequency response suitable for two-way operation. All taps shall be of the directional coupler type. Minimum isolation required between desired and undesired signal paths should be high, nominally 30 dB.

B. Mechanically, the devices should be appropriately designed for the service intended application (i.e., indoor, outdoor, underground, etc.). Fittings should be mechanically and electrically secure, preferably of the center conductor screw-down type.

C. Subscriber installation material such as cable fittings and grounding blocks should be a general good quality to provide firm and safe construction. Where grounding wire, rod, clamps, etc., are used, they shall be selected to conform to pertinent National Electric Code and local electrical safety specifications.

D. Subscriber terminal 75 to 300 ohm balun shall have a low insertion loss, nominally 0.7 dB across the frequency passband.

E. Cable A-B switches should be designed to electrically insert a terminating 75-ohm resistor or the output of the unused cable and provide a high degree of isolation, nominally 60 dB, between the desired and undesired cable signals.

V. General System Design (Refs. 231, 380)

A. The RF System shall be designed to provide for distribution of a minimum of 20 television channels, where required, and additional FM broadcast signals. These television channels shall be contained in the standard television spectrum and in other available spectrum space within the frequency passband.

B. The FM broadcast signals will be carried in the standard FM frequency range of 88 to 108 MHz. These signals shall operate at nominally 15 dB below that of television channel six visual carrier.

C. Other information channels, such as data channels, AM broadcast channels, facsimile channels, etc., may be multiplexed in the transmission spectrum.

D. The System shall be rated for continuous 24-hour service in an environment of up to 100 percent humidity and of temperature variations from -20 degrees F to +100 degrees F.

VI. Trunk System (Refs. 707, 720)

A. Spacing--Spacing between amplifiers shall be optional. A frequently used value is nominally 20 dB of cable as measured at 220 MHz at a cable temperature of 70 degrees F.

B. Signal Levels--Signal level shall be optional as long as the specified subscriber tap levels are maintained. A frequently used value is nominally 30 dBmV at 211.25 MHz. Tilt of other signals shall be optional.

C. Equalization--Each span of cable between amplifiers will be fully equalized in amplitude by the amplifier immediately succeeding the cable span so that cable attenuation and flat loss plus amplifier

gain equals unity at all frequencies in the passband.

D. Temperature Compensation

1. Dual pilot carrier operation is preferred for automatic control of both level and slope under varying temperature.

2. One pilot carrier frequency shall be placed in the low end of the passband for level control. The other will be used in the high end of the passband for slop control.

3. Automatic level-control amplifiers shall operate such that, at their locations, pilot carrier drifts will be held to a mean of $\pm$0.5 dB nominally over the operating temperature.

4. Automatic level-control amplifiers will operate such that at -20 degrees F cross modulation of the trunk system will not be degraded below system performance requirements. At +100 degrees F, the automatic level control amplifiers will operate such that signal-to-noise ratio of any channel is not degraded below system performance requirements.

5. Automatic level-control amplifiers shall be used in sufficient quantities and spaced judiciously to maintain all system performance requirements under varying temperature.

E. Trunk lines shall not be tapped for subscriber connection.

F. All trunk cable shall be terminated with either matched electronic equipment or a termination of 75 ohms characteristic impedance.

G. Splitting of trunk lines is permissible.

VII. Distribution System (Refs. 707, 720)

A. Output Levels--Bridger and line extender amplifier output levels and tilts are optional.

B. Subscriber Tap Levels--The System shall be designed to provide a visual signal level on each channel of not less than one millivolt or 0 dBmV across an impedance of 75 ohms. Maximum output at any tap shall not be in excess of 10 millivolts or +20 dBmV across 75 ohms on any channel.

C. All subscriber taps shall be of the directional coupler type with either 2, 4, or 8 output ports.

D. Line extender amplifiers may be installed in cascade, as designed by system engineering considerations.

E. All distribution cable will be terminated by a terminating multitap or by a termination of 75 ohms characteristic impedance.

F. Splitting of distribution lines will be permitted.

G. Equalization--All distribution cables between amplifiers will be properly equalized in amplitude so that amplifier gain plus cable loss, flat loss, and multitap loss equals unity at all frequencies in the passband.

H. Distribution lines shall be isolated from trunk lines through either bridging amplifiers, distribution amplifiers, or other high isolation devices.

I. Temperature Compensation

1. Automatic level control amplifiers shall be used so that at their locations, pilot carrier drifts will be held to $\pm 1.0$ dB nominally over the operating temperature range.

2. Automatic level control amplifiers shall operate such that all prescribed subscriber tap levels shall be held to a maximum excursion of $\pm 6.0$ dB over the operating temperature range.

3. Automatic level control amplifiers shall operate such that signal-to-noise ratio and cross modulation and intermodulation of the distribution system shall not be degraded below

system performance requirements over the operating temperature range.

## 1.5 System Performance Guidelines (Refs. 231, 318, 380, 402, 698, 706, 707, 720)

The following paragraphs describe the technical specifications for system performance regardless of location or distance. These performance parameters apply over the prescribed temperature operating range of the system from -20 degrees F to +100 degrees F. The specifications relate to factors affecting picture quality in the carriage of NTSC-TV signals within the standard 6 MHz bandwidth channels, as designated by FCC R&R, Section 73.682.

I. Head-End (Ref. 402, 698, 720)

This section covers performance of those portions of the system designed to process and transmit a single television channel (visual and aural) from the source (off-air or origination) to the multiplex combiner located at the distribution hub.

A. Signal-to-Noise Ratio--This ratio of the head-end processing equipment is not specified separately, but included in the overall system specification.

B. Channel Frequency Response--The channel frequency response shall be within a range of $\pm 2$ dB for all frequencies within -1 MHz and +4 MHz of the visual carrier frequency.

C. Video Modulation--Television channel modulators used either as part of the system or as test instruments shall be adjusted to 87.5% $\pm$ 2.5% downward modulation at reference white level with FCC standard composite video waveform as indicated in FCC R&R, Section 73.699, Figure 6 or 7, as applicable.

D. Transfer Linearity--Transfer linearity shall be adjusted for optimum practicable performance at 10 percent, 50 percent, and 90 percent of average picture level (APL). However, differential gain shall not exceed 2 dB, and differential phase shall

not exceed 5 degrees for RF input, or 10 degrees for video input.

E. Transient Response--Transient response to a 2T sine-squared pulse (T = 0.125 microseconds) shall fall within the limits indicated by a 5K rating. (Ref. 706)

F. Chrominance Delay--Chrominance delay relative to luminance, as indicated by response to the modulated 20T pulse, shall not exceed $\pm 150$ nanoseconds. Measurement accuracy shall be $\pm 20$ nanoseconds or better.

G. Low and Mid-Frequency Distortions--Low and mid-frequency distortions, as indicated by response to the 60 Hz window signal, with a 2T transition, shall not exceed 5 IRE units in tilt, rounding, or overshoot. (Ref. 698, Section 73.682)

H. Frequency of Visual Carriers--The frequency of each visual carrier shall be 1.25 $\pm$ 0.025 MHz above the lower boundary of channel assignment.

I. Frequency of Aural Carriers--The frequency of the aural carrier shall be 4 MHz $\pm 1$ kHz above the frequency of the visual carrier.

J. Center Frequency of FM Radio Carriers--The center frequency of all FM radio carriers shall be maintained within $\pm 10$ kHz of the center.

K. Best Engineering Effort--A best engineering effort shall be employed in antenna design, limited only by restrictions imposed by the state-of-the-art and zoning limitations, to avoid or to minimize co-channel interference, electrical noise interference, multipath signals, or excessive fading.

II. Distribution System (Refs. 231, 318, 698, 706, 707, 720)

A. Carrier-to-Noise Ratio (Refs. 698, 707, 712)

1. Definition--The ratio between the rms carrier voltage during sync interval to rms random noise voltage as measured or computed for a 4.0 MHz bandwidth receiver.

2. The carrier-to-noise ratio specification for any television channel in the passband is optional. The FCC limit is 36 dB minimum.

B. Co-Channel Interference*--The ratio of visual signal level to any undesired co-channel television signal operating on proper offset assignment shall be optional. The FCC limit is 36 dB minimum.*

*FCC requirements for performing tests to determine compliance with the standards of R&R, Section 76.605 (a)(9), insofar as it relates to the ratio of visual signal level to any undesired co-channel television signal, and Section 76.605 (a)(10), stating that the ratio of visual signal level to the rms amplitude of any coherent disturbances such as intermodulation products or discrete-frequency interfering signals not operating on proper offset assignments shall not be less than 46 dB, are hereby suspended for all cable television systems pending further action by the FCC.

C. Cross Modulation (Refs. 698, 707, 714)

1. Definition--Defined by NCTA Engineering Standard 002-0267.

2. Specification for any television channel in the passband and over complete temperature range:

   a. No visible evidence of cross modulation shall be noted at any point in the trunk or distribution system. Visible cross modulation is defined as presence of windshield-wiper effect on the television screen.

   b. Cross modulation after any trunk amplifier shall be nominally -57 dB or less. Standards on permissible cross modulation have not been adopted by the FCC.

   c. Cross modulation after any distribution amplifier shall be nominally -51 dB or less. Standards on permissible cross modulation have not been adopted by the FCC.

D. Frequency Response (Refs. 698, 706, 707)

1. Definition--The response, in dB, to a sweep frequency signal, expressed in peak-to-valley ratio in dB, where the peak and the valley are the maximum difference excursions of any frequency in passband, to that of the two end-points of the passband, when the two end-points are aligned on the sweep trace so that they are equal in level to each other.

2. After "n" amplifiers of the trunk system, the peak-to-valley ratio of the frequency response shall be nominally (2 + n/12) dB.

3. After any distribution amplifier the peak-to-valley ratio of the frequency response shall be nominally (2 + n/12 + 3) dB, where "n" is the number of trunk amplifiers in cascade before the distribution line.

4. The peak-to-valley ratio of the frequency response over any 6 MHz channel at any point in the system shall be nominally less than 2 dB.

E. The Visual Signal Level (Refs. 698, 707, 711)

1. Definition--Visual signal level is the rms voltage of a modulated television visual carrier across 75 ohms on a peak reading signal level meter, which is calibrated in rms voltage. For visual carriers this would be the carrier voltage during the sync interval.

2. Visual signal level on each channel within the passband at the subscriber terminals shall be a minimum of 1 millivolt or 0 dBmV across an impedance of 75 ohms, as required by FCC.

3. The variation of visual signal level on each channel within any 24-hour period shall be a maximum of 12 dB, as required by FCC.

4. The visual signal on each channel within the passband shall be maintained within the following FCC requirements:

a. 3 dB of the visual signal level of any visual carrier within 6 MHz nominal frequency separation.

b. 12 dB of the visual signal level on any other channel.

c. A maximum level such that signal degradation due to overload in the subscriber's receiver does not occur.

F. The Aural Signal--The rms voltage of the aural signal shall be maintained between 13 and 17 dB below the associated visual signal level, as required by the FCC.

G. Intermodulation Distortion (Ref. 231, 698, 707)

1. Definition--Intermodulation distortion is any spurious signal generated from either a second order, third order, or higher order beat signal between two or more carriers, or any harmonic generated from one carrier. This spurious signal appears as an interference signal in a channel of either the television or FM broadcast transmissions.

2. Specification

a. No spurious signal shall be apparent as an interfering signal on the television picture of any of the television channel at any point in the trunk or distribution system.

b. Any spurious interference signal generated as a result of intermodulation distortion shall be nominally at least 60 dB down from the interfered channel carrier at any amplifier output in the trunk system.

c. Any spurious interference signal generated as a result of intermodulation distortion shall be nominally at least 60 dB down from the interfered channel carrier at any point in the distribution system.

H. Hum Modulation (Refs. 560, 698, 707)

1. Definition--Hum modulation is the ratio between the level of a detected 60 Hz or 120 Hz signal from a carrier, compared to the detected signal from a 100 percent modulated carrier. Hum modulation is the ratio of one-half the peak-to-peak hum to the average carrier envelope. It can be expressed in decibels from 100 percent or in percentages.

2. Specification--The hum modulation shall be nominally less than 5 percent, as required by the FCC.

I. Echo Distortion (Ref. 707)

1. Definition--Echo distortion is any reflected signal which appears as a trailing ghost in a television picture.

2. Specification--No trailing ghosts will be apparent on any television picture channel as viewed on a standard television receiver at any point in the trunk or distribution system.

J. Direct Pick-up--Any direct pick-up causing leading ghosts or blanking bars shall not be visible on a thoroughly shielded test receiver or converter connected to any service drop. Ghosts, ringing, or reflections of any sort shall be eliminated, or minimized as much as possible, subject to limitations imposed by the technical state-of-the-art.

K. Incidental Radiation (Refs. 534, 698)

1. Definition--Incidental radiation is the electromagnetic radiation in microvolts per meter from any point in the system, at any operating frequency, as measured by a standard dipole located at a proper distance from any point in the system.

2. Specification--Incidental radiation from cable, amplifiers, connector hardware, passive devices shall not exceed the following limits:

a. 15 microvolts per meter at a distance of 100 feet for frequencies up to and including 54 MHz.

b. 20 microvolts per meter at a distance of 10 feet for frequencies over 54 up to and including 216 MHz.

c. 15 microvolts per meter at a distance of 100 feet for frequencies over 216 MHz.

L. Terminal Isolation--The terminal isolation provided each subscriber shall be a minimum of 18 dB as required by the FCC, but in any event, shall be sufficient to prevent reflections caused by open-circuited or short-circuited subscriber terminals from producing visible picture impairments at any other subscriber terminal.

M. Dual Cable Switches--Where applicable, dual cable switches located at subscriber television terminals shall provide isolation between cables of at least 60 dB, and shall have a return loss of 16 dB or greater. No evidence of cross-coupling between the two cables shall be visible on any subscriber's television receiver.

N. AC Primary Voltage Variation--All specifications shall be met for any primary supply voltage variation between 90 and 130 volts AC.

O. Picture Quality

1. Definition--The difference between a picture viewed on a standard television receiver as seen at the head-end and at the terminals of the distribution system.

2. Specification--No television channel shall indicate additional presence of ghosting, hum bars, beat signals, cross modulation interferences other than that seen at head-end. Nor shall any color television picture indicate undue degradation of color fidelity and picture information at the distribution terminals.

P. All relevant FCC technical performance rules shall be complied with.

## 1.6 System Construction Specifications
(Refs. 318, 402, 678, 706, 707, 720)

I. Construction Practices (Refs. 678, 720)

A. Installation and construction practices shall be in accordance with standard utility practice, utility company pole lease agreements, National Electrical Safety Code--Handbook No. 81, as amended by the latest edition, and state, city, and county ordinances.

B. All equipment shall be installed so as to be readily accessible for maintenance and shall be located so as not to interfere with the climbing space or servicing of other pole-mounted equipment. All strands shall be installed on the same side of the pole as the telephone facilities. Where telephone facilities do not exist, the strand shall be installed in the street side of the pole wherever possible.

II. Anchors and Guys (Ref. 707)

The following guide shall be used for anchors and guys. The construction materials shall be used unless otherwise defined by pole lease agreements or any ordinances.

A. The system shall be installed on 1/4" high-strength, seven wire, galvanized, zinc coating "A" supporting strand. The latter shall have a minimum breaking strength of 4,750 pounds.

B. Where three or more consecutive spans exceed 250 feet in any given run, 1/4" extra high-strength, seven wire, galvanized, zinc coating "A" supporting strand, having a minimum breaking strength of 6,600 pounds shall be used.

C. Supporting strand shall be placed at dead-end poles and corner poles where there is an angle of greater than 6 degrees.

D. Anchors shall be 3/4" x 5', 6-inch screw type or 6-inch, 8-way expanding anchor with 5/8" x 6' rod.

E. Guy strand size shall be the same as supporting strand unless otherwise specified.

F. Guys shall be attached to standard pole line hardware and anchor rods using a preformed dead-end or strand vise. Where applicable, an auxiliary eye attachment will be used to attach the guy to an existing anchor rod.

III. System Bonding and Grounding (Refs. 678, 707)

A. The CATV strand shall be bonded to telephone strand and/or other existing pole grounds in accordance with pole lease agreement, except there shall be a minimum bonding between parallel CATV and telephone strands at the first, last, and every tenth pole. Cable television plant shall be grounded at the latter locations.

B. The CATV strand shall be grounded with No. 6 soft drawn bare copper wire at each power supply location using a 5/8" x 8' grounding rod, driven its full length plus 6 inches below the ground.

IV. Cable Installation (Ref. 707)

A. The cable shall be lashed to supporting strand using 0.045 stainless lashing wire having an average of one wrap per linear foot of strand.

B. At each pole and equipment location, the cable and strand shall be separated by use of cable supports and spacers. The lashing wire shall be terminated with a suitable change at each of these locations.

C. Expansion loops shall be made at each pole and at each side of equipment and splice location to provide for expansion of cable caused by temperature variations.

V. Cable Pull-Out (Ref. 720)

All cables will have their center conductor and outer conductor properly seized at any splice or equipment entry so as to prevent cable pull-out due to temperature changes.

VI. Splices and Connectors (Ref. 678)

A. Splices in trunk and feeder cable snall be properly sealed for water-proofing by placing silicone grease on the threads and "O" rings of the splice fittings. No waterproofing compound shall be allowed in the dielectric space.

B. Connectors to amplifiers and other devices shall be protected against moisture by placing silicone grease on threads and "O" rings of all fittings and tightening the fittings according to the manufacturer's specifications.

# 2. CATV SYSTEM TECHNICAL PERFORMANCE MEASUREMENTS

## 2.1 Introduction

This section discusses test procedures applicable to measurement and evaluation of technical performance of CATV systems (Refs. 508, 516, 527, 532, 551, 560, 582) to ascertain compliance with the Federal Communications Commission's performance tests and technical standards set forth under Subpart K of Part 76 of the Commission's Rules and Regulations (Refs. 696, 697).

It is not the intent of this section to outline the most elaborate techniques of measurement. The primary method, using equipment of reasonable cost, is described for each measurement of the various parameters. Where applicable, alternate methods and equipment are given for the measurement of several parameters. Models or manufacturers of test equipment are not specifically given. Pertinent information in this regard can be obtained from the National Cable Television Association, Washington, D.C.

In any measurement good engineering practices must be observed. In setting up test equipment all connecting cables and adaptors should be properly matched. It is desirable to use attenuator pads at connection points to minimize reflections due to mismatch. The proper impedance matching transformers or minimum loss matching pads must be used in interconnecting equipment of different impedance levels. The insertion loss of the matching devices, the signal attenuation of connecting coaxial cables, and the gain of any preamplifier must all be taken into consideration in the measurement result. The foregoing applies to all test procedures and is not redundantly repeated for each procedure.

Proper documentation of all measurements is essential. Test methods used, model and serial number of test equipment, and pertinent calibration information should be described. Sample forms for proper documentation and data recording are given in Ref. 551.

## 2.2 Frequency Measurements
(Refs. 487, 516, 551, 564)

I. Primary Method

A. Introduction

The frequency of a test signal is measured indirectly by the zero beat method. A substitute signal from a signal generator is tuned until its output frequency coincides with the test signal and is displayed by a frequency counter.

B. Test Equipment Required

1. Frequency counter.

2. RF signal generator.

3. Signal Level Meter (SLM).

4. Variable attenuator, 75-ohm impedance, 1-dB increment.

5. Two-way hybrid splitter, two each.

6. One pair of headphones.

7. Resistive terminator, 75 ohm.

8. (Optional) Spectrum analyzer or TV receiver.

C. Test Setup

Refer to Figure 1, page 2-27.

D. Test Procedure

1. Set up the equipment as illustrated in Figure 1, page 2-27.

2. Tune SLM for a peak reading of the test signal and record level.

3. Disconnect test signal input lead to splitter No. 2, which is then terminated with the 75-ohm terminator.

4. Adjust signal generator freouency and output level so as to obtain the same reading on SLM as recorded in step D2. (Note: The signal generator's full output may be required to give stable indication on some frequency counters. If so, the variable attenuator may be used to adjust the signal level fed into the SLM.)

5. Refer to step D3. Remove 75-ohm terminator. Reconnect test signal input lead to splitter No. 2. The SLM will now be receiving two signals of approximately the same frequency.

6. Adjust the signal generator's fine frequency vernier control carefully until the lowest frequency heterodyne (tone) can be heard on the headphones. (Note: When monitoring TV visual carriers, disregard the weak heterodyne, due to sidebands, appearing about 15 kHz above and below the main carrier. Use only the louder center freouency.)

7. Read and record the frequency counter indication.

8. To measure TV aural carrier, the program modulation tends to obscure the heterodyne. Wait for a pause in the program. Then use the above procedure to obtain zero beat.

9. When measuring TV visual carrier, more precise freouency indication can be obtained by substituting a TV receiver in place of the SLM and headphones combination to obtain a true "zero" beat.

E. Optional Method

A spectrum analyzer, if available, may be used in place of the SLM and headphones to indicate frequency coincidence of the test signal and the signal generator. While the spectrum analyzer is more convenient, accuracy in the measurement depends upon the residual FM of the analyzer and how accurately the frequency coincidence is made.

## II. Alternate Method

### A. Introduction

The tracking generator is a special signal source whose RF output frequency tracks (follows) some other signal beyond the tracking generator itself. In conjunction with the spectrum analyzer, the tracking generator produces a signal whose frequency precisely tracks the spectrum analyzer tuning and can be indicated by a counter.

### B. Test Equipment Required

1. Spectrum analyzer.
2. Tracking generator.
3. Frequency counter.

### C. Test Setup

Refer to Figure 2, page 2-27.

### D. Test Procedure

1. Set up the equipment as illustrated in Figure 2, page 2-27.
2. The spectrum analyzer/tracking generator system is used in the open-loop configuration.
3. The test signal is connected to the spectrum analyzer input.
4. The tracking generator output is connected to a frequency counter.
5. The spectrum analyzer is manually scanned to the test signal.
6. The counter displays frequency of the test signal.

### E. Optional Method

The signal processor is capable of stripping modulation and producing a direct output for a

frequency counter. When measuring TV visual and aural carriers within its range, the signal processor can be used to receive the test signal. The processor's output is fed to a counter for readout.

## 2.3 Visual and Aural Signal Levels (Refs. 516, 535, 551)

I. Primary Method

A. Introduction

Measurement of the visual and aural signal levels can be made directly from the spectrum analyzer. For greater accuracy the signal levels are measured one at a time by comparing the amplitude of each signal with the output from a calibrated signal generator on a spectrum analyzer. The measurement can be repeated at regular intervals for a consecutive 24-hour period, if required.

B. Test Equipment Required

1. Calibrated signal generator.

2. Spectrum analyzer.

C. Test Setup

Refer to Figure 3, page 2-28.

D. Test Procedure

1. Set up the equipment as illustrated in Figure 3, page 2-28.

2. Tune the spectrum analyzer for a maximum displayed amplitude of the test signal.

3. Center the display and use the analyzer reference level control to bring the signal level to the top graticule line of the CRT. (Note: When measuring visual signal, it is necessary to use a wide enough resolution

bandwidth of the analyzer to obtain sufficient spectral components. Typically, a 100 kHz bandwidth is required to read the peak value of the carrier in terms of rms volts with the modulation on. A narrower bandwidth would show a lower than actual level.)

4. Use the calibrated signal generator as a substitute device in place of the test signal. Adjust the signal generator's frequency and output level controls to duplicate the result of step D3, in order to verify the amplitude accuracy.

5. Read the generator output level and record the result as the desired signal level.

6. If a calibrated signal generator is not available, calibrate the spectrum analyzer using its internal calibrator. The signal level will then be given by the analyzer Reference Level setting. The accuracy will be a function of the analyzer's internal calibrator accuracy, the flatness of the analyzer, and the Reference Level accuracy.

II. Alternate Method

A. Introduction

A conventional signal level meter may be used for the measurement of visual and aural signals, if a spectrum analyzer is not available. Make certain that the signal level meter is in good working order and has been calibrated prior to usage.

B. Test Equipment Required

Signal level meter.

C. Test Procedure

1. Connect test signal to the signal level meter.

2. Tune signal level meter for a peak reading of the test signal.

3. Measure and record all visual and aural signal levels.

## 2.4 Hum Measurements
(Refs. 493, 516, 551)

I. Primary Method

A. Introduction

Hum modulation of visual carriers can show up on the TV receiver as horizontal bars that move slowly up or down. Due to the close spacing of the modulation sidebands to the carrier, typically 60 or 120 hertz, frequency domain examination of low modulation percentage is difficult. Modulation of this type is conveniently measured in the time domain. An unmodulated carrier is tuned and detected by a spectrum analyzer used in the zero scan time domain mode. The analyzer's video output is then fed to an oscilloscope to observe and measure the ac hum.

B. Test Equipment Required

1. Spectrum analyzer

2. Oscilloscope.

3. RF signal generator.

C. Test Setup

Refer to Figure 4, page 2-28.

D. Test Procedure

1. Set up the equipment as illustrated in Figure 4, page 2-28.

2. The test signal should be unmodulated. When measuring visual carrier substitute an unmodulated carrier of the same frequency and amplitude from the signal generator.

3. Connect the analyzer's video output to the oscilloscope vertical input with a shielded lead. To minimize stray hum loops, make sure that there is no other ground on the oscilloscope case. If the oscilloscope has a three-pin power plug, use a two-pin adapter which has no ground pin. Synchronize the oscilloscope to the "line" at a frequency of 30 or 60 hertz.

4. The analyzer is used in the zero scan time domain mode as a filter and detector. The resolution bandwidth should be set to 30 kHz. Tune the analyzer to the desired unmodulated carrier.

5. Place oscilloscope in direct-coupled mode. Adjust scope gain and centering so that, with the signal source disconnected temporarily, the trace is on the bottom line of the scope screen and, with the signal source reconnected, the trace is in view and goes to a convenient line. Measure and record the dc voltage for later computation.

6. Switch the oscilloscope to ac coupling and center the trace vertically. Increase vertical gain of the scope sufficiently to measure and record the peak-to-peak ac voltage for later computation.

7. Hum modulation is usually symmetrical, varying both above and below the unmodulated level. Percent modulation is given by the formula:

$$\text{percent modulation} = 100\ (E_{max} - E_{min})/(E_{max} + E_{min})$$

or

$$\text{percent modulation} = 100\ (\text{p-p variation})/2\ (\text{ave. level}),$$

where (p-p variation) is the ac voltage measured in step D6, where (ave. level) is the dc voltage measured in step D5.

8. Measurement accuracy can be improved in the presence of noise by integrating the noise. This is done by shunting the vertical input of the oscilloscope with a capacitor chosen to have no effect on the amplitude of the ac component.

II. Alternate Method

If a spectrum analyzer is not available, a conventional signal level meter may be used for the hum measurements. The use of a battery powered signal level meter is recommended to prevent any power line "ripple" from being introduced into the measurement. The test procedure is essentially the same as outlined in the primary method of 2.4 I, with the exception that the spectrum analyzer is replaced by the signal level meter.

## 2.5 Channel Frequency Response (Refs. 516, 551, 582)

I. Primary Method

A. Introduction

The individual channel frequency response is checked from at least 1 MHz below the visual carrier to 4 MHz above. The test is done in two parts. First, the CATV distribution system response is determined. Then the single channel signal processing equipment at the head-end is separately measured. The results of the two parts are combined to yield the overall measurement. A simultaneous sweep system is used for the test without removing TV channel from service.

B. Test Equipment Required

1. Simultaneous sweep transmitter.
2. Simultaneous sweep receiver.
3. Marker generator.
4. Signal level meter.
5. TV receiver.
6. Camera.

C. Test Setup

Refer to Figure 5, page 2-28.

D. Test Procedure

1. Set up the simultaneous sweep transmitter in the CATV system head-end. Usually, the sweeper can be inserted through a directional coupler ahead of the system output test point.

2. Adjust sweep output level 10 to 15 dB above the channel visual carrier level. Establish the output level in the CW mode, monitoring with signal level meter on the output test point.

3. Set up the sweeper for a 2-millisecond sweep rate and select a 5- to 20-second repetition rate. Adjust the sweep bandwidth to cover the desired frequency range, using the marker generator to define channel boundary.

4. Observe the test channel on the TV receiver to verify that interference from the simultaneous sweep system is negligible.

5. Mark trace of the reference level on the sweep receiver. Using the sweeper's built-in step attenuators, marke traces higher or lower than the reference level in desired decibel steps for further reference.

6. Bring simultaneous sweep receiver to selected test site. Connect test signal to the sweep receiver. Observe and photograph response curve. Measure channel frequency flatness using reference traces established in setp D5.

7. Return to head-end. Determine frequency response of single channel signal processing equipment.

8. Combine results of steps D6 and D7 for overall channel frequency response.

II. Alternate Method

A. Introduction

If a simultaneous sweep system is not available, a manual point-by-point method of channel frequency response testing can be done by using a CW signal

generator at the head-end and a signal level meter at the test location. However, radio or telephone communication between the head-end and test location is required.

B. Test Equipment Required

1. RF signal generator.

2. Signal level meter.

C. Test Setup

Refer to Figure 6, page 2-29.

D. Test Procedure

1. Measure the output level of the signal processor for the channel under test at the head-end with the signal level meter.

2. Switch the signal processor to manual mode of operation. Set manual gain to give the same output level as measured in step D1. If applicable, disable the internal substitution carrier of the signal processor.

3. Remove antenna feed for the channel under test and connect the signal generator in its place.

4. Adjust signal generator frequency and output level so that the signal processor output level is the same as measured in step D1.

5. At the test location of the system, this signal is measured with the signal level meter.

6. The signal generator frequency is changed in desired increments, such as 0.5 MHz, to cover the required range of one MHz below the visual carrier frequency to four MHz above. For each frequency setting, make sure that signal generator output has not changed. Measure and record the signal level for each frequency.

## 2.6 Carrier-to-Noise Measurements (Refs. 514, 551, 560)

### I. Primary Method

#### A. Introduction

The noise level in each channel is measured with a spectrum analyzer. The displayed noise level reads low due to two factors. First, the analyzer resolution bandwidth is to be normalized to the required 4 MHz, since noise power is proportional to bandwidth. The second factor is due to the log shaping and detector characteristics of the analyzer. The corrected noise level will be compared to the visual carrier level to obtain the carrier to noise ratio.

#### B. Test Equipment Required

1. Spectrum analyzer.

2. Tunable bandpass filter, 6 MHz bandwidth.

#### C. Test Setup

Refer to Figure 7, page 2-29.

#### D. Test Procedure

1. The test signal is connected through a tunable bandpass filter to the spectrum analyzer.

2. Tune both the filter and analyzer to the channel under test for a maximum displayed amplitude of the visual carrier. Use a 100 kHz resolution bandwidth on the analyzer, but the video filter is not used.

3. Use the reference level control of the analyzer to place this signal on the top graticule line of the CRT.

4. Tune the bandpass filter slightly to insure that the noise in the spectrum between the visual carrier and color burst is a maximum. Change the analyzer resolution bandwidth to 10 kHz.

Use sufficient video filtering to smooth out the noise display. The sweep speed of the analyzer should be slowed down to avoid "sweep rate errors."

5. The displayed noise level should be measured directly from the analyzer screen to ascertain the number of decibels down from the top graticule line.

6. The displayed noise level is to be increased by the appropriate correction factor recommended by the analyzer manufacturer. Subtract this correction in decibels from the number of decibels obtained in step D5 to give the carrier-to-noise ratio.

## II. Alternate Method

### A. Introduction

If a spectrum analyzer is not available, the conventional signal level meter, with suitable correction, can be used for the measurement of carrier-to-noise ratio. Noise indication of the signal level meter is to be corrected upward due to normalizing of the IF bandwidth to 4 MHz. A second correction is in the opposite direction, because the peak detector commonly used by signal level meter gives higher noise reading. (Noise has a higher peak to RMS ratio than CW signals. As the detector output is reduced, its efficiency is lowered and reads closer to RMS value.)

### B. Test Equipment Required

1. Signal level meter (SLM).

2. Variable attenuator, 75 ohm, range of 60 dB, in 1 dB steps.

3. Tunable bandpass filter, 6 MHz bandwidth.

4. Resistive terminator, 75 ohm.

### C. Test Setup

Refer to Figure 8, page 2-29.

D. Test Procedure

1. Set up equipment as illustrated in Figure 8, page 2-29.

2. Switch in 60 dB of attenuation in variable attenuator.

3. Place signal level meter on its most sensitive range.

4. Tune the SLM to a peak reading at the center of visual carrier for the test channel. Adjust variable attenuator setting, SLM compensator setting, and/or SLM meter range to give a convenient reference reading, such as center scale, on the SLM.

5. At the head-end, adjust the signal processor for the test channel to manual mode of operation. Set manual controls for normal operating level. Remove antenna input lead form signal processor, and substitute a 75-ohm terminator in its place. (Disable substitute carrier generator in signal processor, if applicable.)

6. Tune the SLM carefully across the test channel for minimum noise reading. Remove attenuation from the variable attenuator until the same reference reading of step D4 is obtained. Record the amount of attenuation in decibels removed.

7. The SLM's indicated noise level is to be increased by the appropriate correction factor. (This correction factor may be determined by having the SLM calibrated on a known noise source. Otherwise, use the average correction recommended by the SLM manufacturer.) Subtract this correction in decibels from the number of decibels obtained in step D6 for the carrier-to-noise ratio.

8. For greater noise measurement accuracy, it is desirable that all carriers be removed from the system except the pilot carriers required for automatic gain and/or slope controls.

## 2.7 Co-Channel Interference Measurements (Refs. 486, 516, 551)

### I. Primary Method

#### A. Introduction

Offset co-channel interference is measured with a calibrated spectrum analyzer of adequate selectivity. The test channel signal is fed to an analyzer through a tunable bandpass filter. The filter is used to prevent the possibility of the analyzer contributing any distortion to the measurement. The amplitudes of the desired visual carrier and co-channel interference, if any, are displayed on the analyzer for direct comparison.

#### B. Test Equipment Required

1. Spectrum Analyzer.

2. Tunable bandpass filter, 6 MHz bandwidth.

#### C. Test Setup

Refer to Figure 7, page 2-29.

#### D. Test Procedure

1. The test signal is connected to the spectrum analyzer through a tunable bandpass filter.

2. Tune both the filter and the analyzer to the channel under test for a maximum displayed amplitude of the visual carrier.

3. Reduce frequency scan of the analyzer to 10 kHz per division with a resolution bandwidth of 1 kHz or less. Maximum video filtering should be used so that the video information will not obscure the display.

4. Center the visual carrier display. If co-channel interference is present, it will appear as an additional carrier in a position 10 or 20 kHz either side of the visual carrier.

5. Measure and record the level of co-channel interference relative to the visual carrier.

6. For greater accuracy, set the visual carrier level at the reference level on the CRT, and read the reference level setting. Then use the reference level control to bring the interference product to the top of the CRT. Subtract these two reference level settings to get the ratio of the visual carrier signal to the co-channel interference.

II. Alternate Method

An approximate method may be used if a spectrum analyzer is unavailable. This method consists of visually examining the test channel (Channel A) on a TV screen for possible offset co-channel interference as indicated by "venetian blind" effect. If such interference is observed, its level may be determined roughly by the use of a substitution oscillator. Tune the oscillator to simulate the observed co-channel beat on another TV channel free of interference (Channel B). Display both Channels A and B simultaneously on two TV receivers. The level and frequency of the substitute oscillator signal are finely adjusted to create a similar type of interference on Channel B as that observed on Channel A. The oscillator level may then be measured by a signal level meter to give the approximate value of co-channel interference.

## 2.8 Intermodulation Measurements (Refs. 493, 516, 527)

I. Primary Method

A. Introduction

Intermodulation is defined as the generation of sinusoidal components having frequencies equal to the sums and differences of integral multiples of the frequencies of the sinusoidal components introduced into the system. This occurs when the transfer characteristic of the system is nonlinear. Intermodulation distortion is measured with a calibrated

spectrum analyzer of adequate selectivity. The test channel is fed to an analyzer through a tunable bandpass filter. The amplitudes of the desired visual carrier and intermodulation products are displayed on the analyzer for direct comparison. This test may be performed with modulation on in the channel under test by using maximum video filtering to eliminate the video. However, since intermodulation components may be present coincident with one of the discrete sidebands, it is best to turn the modulation off.

B. Test Equipment Required

1. Spectrum Analyzer.

2. Tunable bandpass filter, 6 MHz bandwidth.

3. RF signal generator.

C. Test Setup

Refer to Figure 7, page 2-29.

D. Test Procedure

1. The test signal should be unmodulated. When testing a TV channel, replace the visual carrier with an unmodulated carrier of the same frequency and amplitude from the RF signal generator at the head-end.

2. At the test location, the test signal is connected to the spectrum analyzer through a tunable bandpass filter. The filter is used to prevent the possibility of the analyzer contributing any distortion to the measurement.

3. Tune both the bandpass filter and the analyzer to the channel under test for a maximum displayed amplitude of the unmodulated carrier.

4. Set the unmodulated carrier level at the reference level on the analyzer CRT, and read the reference level setting.

5. Scan the entire channel under test carefully for discrete interference products by varying the

analyzer scan, resolution bandwidth and sweep time controls.

6. Bring the interference product to the top of the analyzer CRT with the reference level control. Read the reference level setting.

7. Subtract the reference level setting obtained in step D6 from that of step D4 to give the ratio of the intermodulation interference ratio.

8. To insure that the analyzer is not contributing distortion, change the input attenuator of the analyzer by, say, 10 dB. If all signals change by exactly 10 dB, they are real spurious interference signals and not created by the spectrum analyzer.

## 2.9 Cross Modulation Measurements (Refs. 493, 560, 714)

### I. Primary Method

#### A. Introduction

Cross modulation is the transfer or "crossing" of modulation from the interfering signal or signals to the desired signal. This occurs when the transfer characteristic of the system is nonlinear. In a CATV system, severe cross modulation results in a weak reproduction of the picture of the interfering channel superimposed on the picture being viewed. Since the receiver's horizontal scanning is synchronized with the wanted signal but usually not with the interfering one, the two horizontal frequencies usually differ slightly. Consequently, the interfering picture moves back and forth across the TV screen, producing slanting bars which give the so-called "windshield wiper" effect. The equipment required to measure cross modulation will consist of a transmitting and a receiving package. The transmitting package is a multi-carrier signal generator unit whose output frequencies correspond to the TV channel assignments of the system being tested. The carriers are 100 percent modulated

synchronously by a symmetric square wave having a frequency of 15.75 kHz. The modulation of each carrier of the multi-carrier signal generator may be individually turned on or off, and the output level of each carrier may be adjusted separately. The receiving package consists of a signal level meter (SLM) and a narrow bandwidth wave analyzer. At the test location, the SLM is tuned to a CW carrier for the channel under test, while all other channels are 100 percent modulated. The video output of the SLM is connected to the wave analyzer, which is tuned to 15.75 kHz and has been calibrated for 100 percent modulation. Read cross modulation directly on the wave analyzer.

B. Test Equipment Required

1. Multicarrier signal generator unit.

2. Signal level meter (SLM).

3. Tunable bandpass filter, 6 MHz bandwidth.

4. Wave analyzer.

5. Variable attenuator, 75-ohm impedance, 1-dB increment.

C. Test Setup

Refer to Figure 9, page 2-30.

D. Test Procedure

1. At the head-end of the CATV system replace all signals (except pilot carriers) with signals of the multi-carrier signal generator unit, whose output frequencies correspond to the frequencies of the system's visual carriers.

2. Adjust the level of each carrier to normal system operating level.

3. Turn off the modulation for the carrier of the channel under test. All other carriers are 100 percent modulated synchronously by a symmetric square wave having a frequency of 15.75 kHz.

4. At the test location, set up the equipment as illustrated in Figure 9, page 2-30.

5. Tune both the bandpass filter and the SLM for a peak reading of a modulated carrier, such as one for a channel adjacent to the channel under test.

6. Adjust the variable attenuator so that the SLM reads a signal level of +10 dBmV.

7. Connect the SLM's video output to the wave analyzer. Tune the wave analyzer for a peak reading at 15.75 kHz. Calibrate the wave analyzer for 100 percent modulation.

8. Repeat steps D5 to D7, but tune the bandpass filter and the SLM to the unmodulated carrier of the channel under test. Read the cross modulation directly on the wave analyzer.

## 2.10 Terminal Isolation Measurements (Refs. 516, 535, 551)

I. Primary Method

A. Introduction

The procedure for measuring terminal isolation involves using a leveled sweep oscillator at one subscriber terminal to sweep slowly across the frequency band of interest, and the output observed with a spectrum analyzer at an adjacent subscriber terminal. Terminal isolation is dependent, to a great degree, on the use of proper terminations at all cable outlets.

B. Test Equipment Required

1. Spectrum analyzer.

2. Sweep oscillator.

C. Test Setup

Refer to Figure 10, page 2-31.

D. Test Procedure

1. Adjust controls of the sweep oscillator to sweep slowly across the frequency band of interest with a leveled output.

2. Measure the sweeper's output level on the spectrum analyzer by using the analyzer's reference level control to bring the trace to the top of the CRT. Note the reference level setting.

3. Remove CATV signals from the distribution leg to be tested. Backfeed the sweep oscillator to the system from a subscriber terminal location, or a simulated one.

4. At the adjacent subscriber terminal, set the analyzer to scan the same range of frequency using a 100 kHz or greater resolution bandwidth and a rapid sweep rate. Use variable persistence, if available, to print out the response on the CRT.

5. Use the reference level control to bring the response trace to the top of the CRT. Read the reference level setting. Subtract this setting from the output level of the sweeper as noted in step D2 to get the terminal isolation in decibels.

II. Alternate Method

A. Introduction

If a spectrum analyzer or sweep oscillator is not available, the terminal isolation may be measured in the following fashion. A signal from a RF signal generator is backfed into the system from one subscriber terminal. How much signal arriving at an adjacent subscriber terminal is measured with a signal level meter to determine the terminal isolation at a given frequency. The procedure is then repeated for other frequencies.

B. Test Equipment Required

1. RF signal generator.

2. Signal level meter (SLM).

3. Variable attenuator, 75-ohm impedance, 1-dB increment.

C. Test Setup

Refer to Figure 11, page 2-31.

D. Test Procedure

1. Remove CATV signals from the distribution leg to be tested.

2. Adjust RF signal generator controls to supply a high-level, say, +30 dBmV, signal of the desired frequency.

3. Switch in a given amount, say, 25 dB, of attenuation in variable attenuator.

4. Connect RF signal generator output through the variable attenuator to the SLM. Tune the SLM for a peak reading of the desired signal.

5. Adjust variable attenuator setting, SLM compensator setting, and/or SLM meter range to give a convenient reference reading, such as center scale, on the SLM. Record both the variable attenuator setting and the SLM reading.

6. Back-feed the signal generator output to the system from a subscriber terminal location, or a simulated one. Make sure that the generator's frequency and output level remain the same as those used in step D2.

7. At the adjacent subscriber terminal, read the signal level with the SLM through the variable attenuator. The SLM compensator setting, and/or the SLM meter range, and the variable attenuator setting remain the same as those used in step D5.

8. Remove attenuation from the variable attenuator until the same reference reading of step D5 is obtained on the SLM. The amount of attenuation in decibels removed gives the terminal isolation at the selected frequency. The procedure outlined from steps D1 through D8 is repeated for other frequencies as desired.

## 2.11 Radiation Measurements (Refs. 526, 533, 534)

### I. Primary Method

#### A. Introduction

A resonant dipole antenna is used to measure an unknown field strength which can be related to the voltage measured at the end of a properly terminated transmission line. A balanced to unbalanced transition, or balun, is needed to match the dipole with the unbalanced coaxial cable normally used to feed the signal to a measuring device, such as a spectrum analyzer or signal level meter, which is preceded by a broadband preamplifier to increase its sensitivity.

The antenna length required to resonate at a given frequency (independently of any dielectric effects) depends upon the ratio of the length of the conductor to its diameter. If the antenna is made of rod or tubing and is not loaded unduly near the ends by insulators, the following formula will give the required physical length of a half-wave antenna in inches:

$$\text{Length (inches)} = (5905 \times k)/f(\text{MHz})$$

where k is a function of the ratio of the free-space half wavelength to the conductor diameter and f is the frequency in megahertz. For all practical purposes, the value of k may be taken to be 0.95. Then the physical length of a resonant half wavelength antenna is given as:

$$\text{Length (inches)} = (5610)/f(\text{MHz})$$

When a 75-ohm, half-wave dipole antenna is exposed to an RF field, the rms voltage delivered to a 75-ohm load is:

V = (The square root of 75) x 5.58 x E/f

where V is the output voltage in microvolts rms, E is the field strength in microvolts per meter, and f is the signal frequency in megahertz.

Conversely, if the voltage is known, the field strength is given by:

E = (0.0207)(V)(f) for 75-ohm antenna.

Radiation from a CATV system is likely to be both complex and different for each case. Its measurement will be affected by many factors, such as local standing wave conditions; ambient signals; auto ignition and high-level urban noises; and the presence of reflections from other wires, the ground, and nearby vehicles and buildings. It is recommended that, whenever possible, measurements of radiation be made at locations free of interference, using frequencies free of strong, off-the-air signals. If radiation is detected, probe around and find the spot where the signal is strongest to verify the measurement.

B. Test Equipment Required

1. Resonant dipole antenna, 75 ohm.

2. Balanced to unbalanced balun, 75 ohm.

3. Broadband preamplifier.

4. RF signal generator.

5. Spectrum analyzer or signal level meter.

C. Test Setup

Refer to Figure 12, page 2-31.

D. Test Procedure

1. Adjust the physical length of the dipole antenna to be a resonant half wavelength for the frequency being tested in accordance with the formula discussed in the 2.11 Introduction:

$$\text{Length (inches)} = (5610)/f(\text{MHz})$$

2. Adjust RF signal generator controls to supply a low-level signal, say, -30 dBmV, at the test frequency to the spectrum analyzer.

3. After the analyzer has been tuned to a peak reading at the test frequency, it is disconnected.

4. Connect the dipole antenna through the balun and the broadband preamplifier to the analyzer.

5. Keeping the antenna at the required distance from the test object, probe for presence of signal at the test frequency as monitored by the analyzer which has been pretuned in step D3.

6. If radiation is detected, maintain the specified separation while hunting for the location where the signal is strongest.

7. Record the signal level displayed by the analyzer. Make corrections due to gain of the preamplifier, loss of connecting coaxial cable, and loss of balun, if any.

8. Calculate the field strength, E in microvolts per meter, from the corrected rms voltage, V in microvolts, at the test frequency, f in megahertz, by the formula discussed in the 2.11 Introduction:

$$E = (0.0207) \times (V) \times (f) \text{ for 75-ohm system.}$$

9. Part 76, Subpart K, of the FCC Rules and Regulations governs the technical standards applicable to radiation from a cable television system. Section 76.605(a)(12) gives the radiation limit to be 15 microvolts per meter at a distance of 100 feet for frequencies up to and including

54 MHz, 20 microvolts per meter at a distance of 10 feet for frequencies over 54 up to and including 216 Mhz, and 15 microvolts per meter at a distance of 100 feet for frequencies over 216 MHz.

## 2.12 Measurement Test Setups

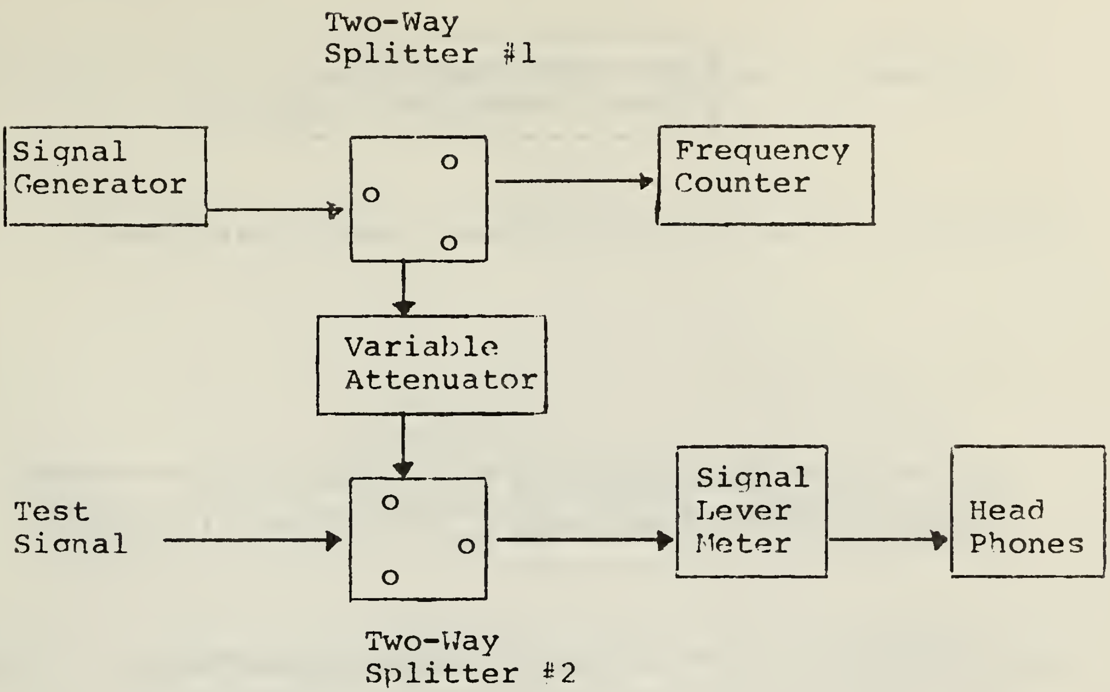


Figure 1. Test Setup for Frequency Measurements


Figure 2. Test Setup for Frequency Measurements, Alternate Method

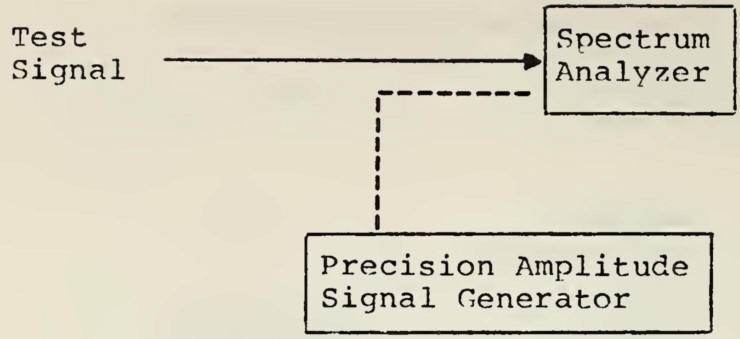


Figure 3. Test Setup for Signal Level Measurements

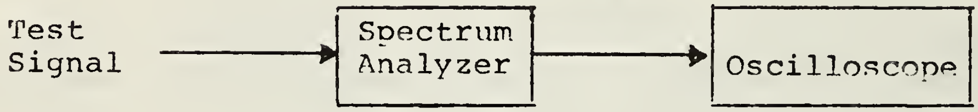


Figure 4. Test Setup for Hum Measurements

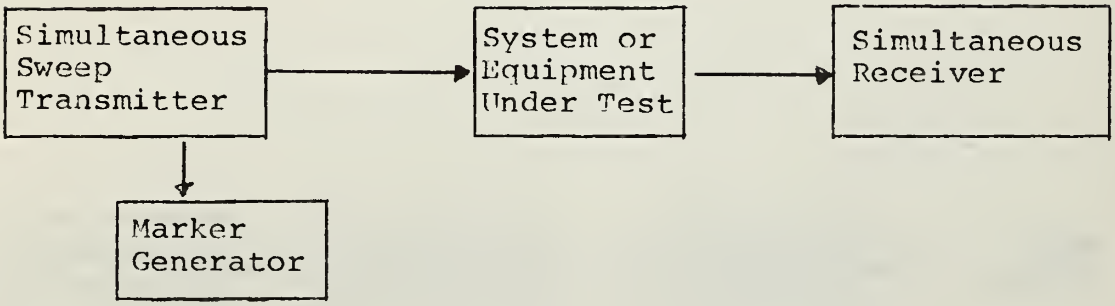


Figure 5. Test Setup for Channel Frequency Response

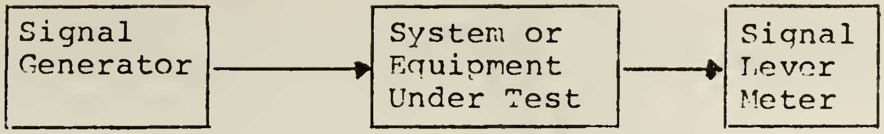


Figure 6. Test Setup for Channel Frequency Response, Alternate Method

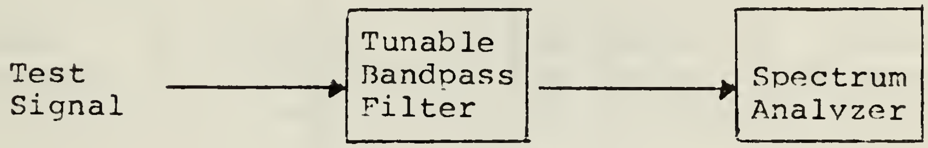


Figure 7. Test Setup for Measurements of Carrier to Noise, Co-Channel Interference, and Intermodulation


Figure 8. Test Setup for Carrier to Noise Measurements, Alternate Method

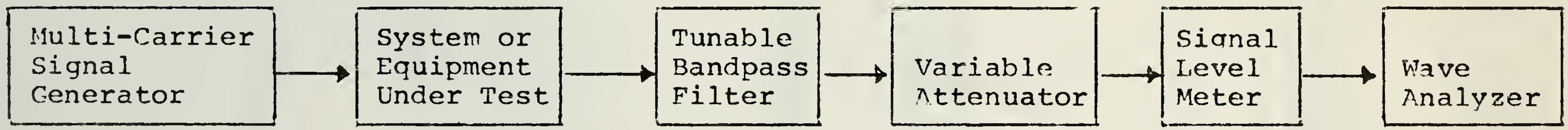


Figure 9. Test Setup for Cross Modulation Measurement

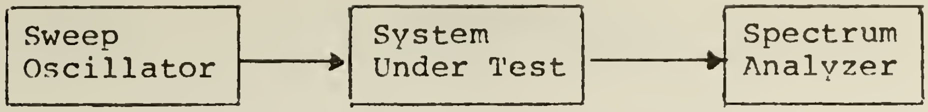


Figure 10. Test Setup for Terminal Isolation Measurement

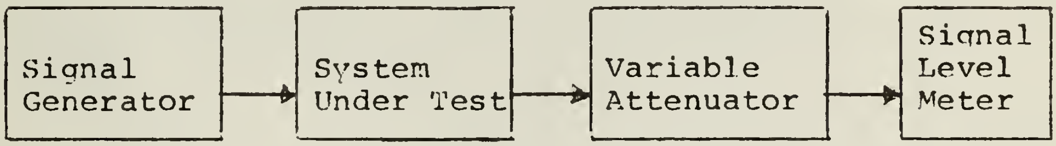


Figure 11. Test Setup for Terminal Isolation Measurement, Alternate Method

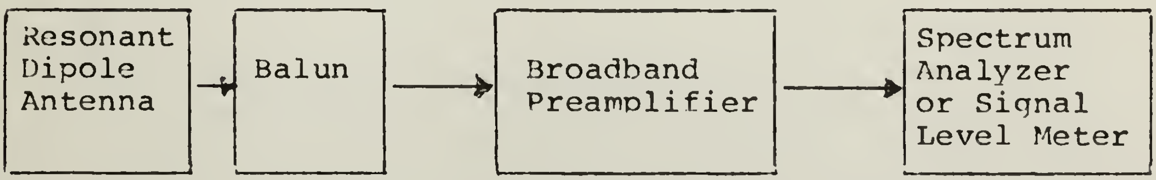


Figure 12. Test Setup for Radiation Measurements

# 3. BIBLIOGRAPHY

## 3.1 Introduction

This section consists of a bibliography of technical publications related to cable television systems. The reader is specifically referred to the seven-volume OT Report 73-13 entitled, "A Survey of Technical Requirements for Broadband Cable Teleservices," published by the Office of Telecommunications, U.S. Department of Commerce. Most of the technical references of OT Report 73-13 have been selectively included in this section with the addition of up-to-date references. There are 307 references, which have been organized into ten subject areas listed in the Table of Contents. This organization is intended to aid in introducing the reader to specific subject areas.

## 3.2 Head-Ends, Central Processors, and Origination Equipment


1. Arndt, G., F. Stuber, and R. Panneton (1973), Video-signal improvement using comb filtering techniques, IEEE Transactions on Communications, COM-21, April.

2. Behrend, W. (1956), (1959), Reduction of co-channel interference by precise frequency control of TV picture carriers, RCA Review, Vol. 17, p. 443, Vol. 20, p. 347.

3. Benson, B. (1974), Helical video tape interchangeability requirements, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

4. Best, A. (1974), Signal processing requirements for modern cable systems, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

5. Best, A. (1970), The CATV modulator, 19th Annual NCTA Convention, Official Transcript.

6. Best, A. (1972), One hundred proof and a good head-end, TV Communications, November.

7. Bingham, M. (1970), An inside look at Dynair's RX-4B CATV headend demodulator, 19th Annual NCTA Convention, Official Transcript.

8. Biro, S. (1972), Antenna site and head-end selection problems in big city CATV systems, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

9. Biro, S. (1971), Antenna radiation pattern analysis and co-channel protection, 20th Annual NCTA Convention, Official Transcript.

10. Biro, S. (1970), Analysis of minimum head-end engineering requirements for satellite CATV reception, 19th Annual NCTA Convention, Official Transcript.

11. Biro, S. (1969), Minimum acceptance testing of CATV head-ends, TV Communications, October.

12. Broadcast Engineering (1972), Upgrading your antenna system, p. CE-2, December.

13. Broadcast Engineering (1972), Accelerating tape duplication, p. CE-9, November.

14. Carter, B. (1969), Solid-state signal modulators for CATV head-end processing, TV Communications, November.

15. Carter, B. (1969), Solid-state signal modulators for CATV head-end processing, TV Communications, November.

16. Community Antenna Television Journal (1974), Using the parabolic for distant off-the-air signals, July.

17. Community Antenna Television Journal (1974), Nullify co-channel with antenna spacing, June.

18. Conte, P. and S. Biro (1974), The phazar, a new interference rejection device, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

19. Deger, E. (1973), Economically optimum receiver design, IEEE Transactions on Broadcast and TV Receivers, February.

20. Digital Communications Corporation (1973), DATE, Digital audio for television, Rockville, Maryland.

21. Doering, R. (1970), The feasibility of low cost FM cablecasting, 19th Annual NCTA Convention, Official Transcript.

22. Dolan, J. (1969), Head-end test equipment: how much do you need?, TV Communications, May.

23. Dougherty, H. and R. Wilkerson (1967), Determination of antenna height for protection against microwave diffraction fading, Radio Science, Volume 2.

24. Electronics Industries Association (1971), A guide to helical scan tape recording, Industrial Electronics Bulletin, Washington, D.C.

25. Farmer, J. (1973), Application of phase locked modulators and processors, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

26. Farmer, J. (1973), And two phaselocks in every home, TV Communications, October and November.

27. Fowler, A. and F. Beltran (1971), The use of zig zag antenna in cable systems, 20th Annual NCTA Convention, Official Transcript.

28. Fowler, A. (1969), Antenna performance data and antenna selection, 18th Annual NCTA Convention, Official Transcript.

29. Genochio, F. (1974), Aural services for the FM band, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

30. Guthrie, E. (1970), Evaluation of intermodulation distortion in up converters and down converters for CARS band systems, 19th Annual NCTA Convention, Official Transcript.

31. Haines, F. and G. Hobbs (1969), A low cost color camera for cablecasting, 18th Annual NCTA Convention, Official Transcript.

32. Horrigan, E. (undated), Performance calculations for VHF television rebroadcasting systems, Engineering Division, Canadian Broadcasting Corporation.

33. Hymas, R. (1971), A new approach to all-digital non-duplication switching, 20th Annual NCTA Convention, Official Transcript.

34. Johnson, C. (1969), A comparison of synchronous and envelope detection in demodulators for CATV, 18th Annual NCTA Convention, Official Transcript.

35. Johnson, W. (1969), CARS bank microwave, what it is and what it can do for the CATV operator, 18th Annual NCTA Convention, Official Transcript.

36. Kaylor, K. (1971), Telcine systems for the CATV origination center, 20th Annual NCTA Convention, Official Transcript.

37. Kaylor, K. (1970), Low cost color van, 19th Annual NCTA Convention, Official Transcript.

38. Keyes, L. (1972), The T-matic videocassette program automation system, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

39. Keys, L. (1972), A basic video primer for CATV technicians, TV Communications, February and March.

40. Lawson, K. (1970), Trade-offs in local origination, 19th Annual NCTA Convention, Official Transcript.

41. Manuel, D. (1973), Your attention please, this is an emergency alert, TV Communications, January.

42. Marks, H. and A. Thompson (1971), High energy tape for video recording applications, 20th Annual NCTA Convention, Official Transcript, Technical Volume.

43. Marx, F. (1971), ABTO system for CATV programming, 20th Annual NCTA Convention, Official Transcript.

44. Mertz, E. (1970), Electromagnetic interference shielding techniques, TV Communications, March.

45. Momberger, R. (1973), The frame grabber is a picture thief, TV Communications, January.

46. Nelson, L. (1970), Design of the local origination studio, 19th Annual NCTA Convention, Official Transcript.

47. O'Connor, R. (1968), Understanding television's grade A and grade B service contours, IEEE Transactions on Broadcasting, April.

48. O'Neill, J. (1972), Technical and economic investigation of the interconnection of WCS's multiple head-ends, The MITRE Corporation, WP-8542, Washington, D. C.

49. Osborne, W. (1969), Demodulation and modulation of television waveforms, 18th Annual NCTA Convention, Official Transcript.

50. Pace, R. (1969), Rx: Signal processing, 18th Annual NCTA Convention, Official Transcript.

51. Paulson, R. (1974), Teleproduction and automatic programming system for low-cost cassette and open-reel VTR's, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

52. Paulson, R. (1973), Standalone time base corrector systems for CATV program production duplicating, and cablecasting, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

53. Pistor, J. (1973), The cassette-loading super 8 video-player -- a means for originating film programs, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

54. Rabowsky, I., C. Meyers, and P. Vaughan (1973), A high power single channel AML microwave relay system, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

55. Reynolds, K. (1973), A one-inch video cartridge recorder designed for professional CCTV and CATV, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

56. Reynolds, K. (1971), Helical scan VTR's and the cablecaster, 20th Annual NCTA Convention, Official Transcript.

57. Reynolds, K. (1969), A high quality, low cost, color VTR, 18th Annual NCTA Convention, Official Transcript.

58. Rickel, J. (1971), Special effects generators provide spice for the eye, TV Communications, June.

59. Rickel, J. (1970), Audio-video signal switching -- Part II, TV Communications, August.

60. Roche, J. (1973), Towards a more economic microwave system for CATV, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

61. Rogers, R. (1972), Texas community antennas: harnessing the computer, TV Communications, February.

62. Ronald, M. (1969), Antenna design, using scale models, 18th Annual NCTA Convention, Official Transcript.

63. St. Louis, R. (1974), A hard look at head end processing or strip amps, heterodynes, and demods, TV Communications, February.

64. Sands, L. (1971), Don't run for the hills, Broadcast Engineering, November.

65. Scientific-Atlanta, Inc. (1969), Model 6100 CATV solid state processor, Atlanta, Georgia.

66. Skolnik, M. (1969), Large antenna systems, in Antenna Theory, Part 2, McGraw-Hill, New York.

67. Smith, E., R. Rosich, E. Hayden, and L. Melanson (1973), System control facilities: head-ends and central processors, U. S. Department of Commerce, Office of Telecommunications Report, OTR 73-13, Volume 4.

68. Smith, T. (1973), So how come I get a signal here and not right over there, TV Communications, May.

69. Smith, T. (1965), Basic antenna array theory, discussed with respect to minimizing co-channel interference, 14th Annual NCTA Convention, Official Transcript.

70. Smith, T. and J. Dillon (1970), CARS band remote to head-end link, 19th Annual NCTA Convention, Official Transcript.

71. Southworth, G. and C. Wenzinger (1969), Local origination for CATV systems using slow-scan TV techniques and electronic character generation systems, 18th Annual NCTA Convention, Official Transcript.

72. Summers, J. (1973), Selecting antenna sites: theoretical vs. empirical, TV Communications, October.

73. Switzer, I. (1974), Phase phiddling, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

74. Switzer, I. (1970), New antenna features guaranteed parameters, TV Communications, November.

75. Vigantz, A. (1968), Space-diversity performance as a function of antenna separation, IEEE Transactions on Communications, Volume COM-16.

76. Vogelman, J. (1969), Quasi-laser link modulation means for wide spectrum airlink CATV services, 18th Annual NCTA Convention, Official Transcript.

77. Williams, W. (1965), High efficiency antenna reflection, Microwave Journal, July.

78. Wise, B. (1972), Audio equipment for CATV, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

79. Ackerlind, E. (1972), Cross modulation ratio, IEEE Transactions on Broadcasting, December.

80. Arndt, G. (1970), Signal-to-noise enhancement using a super conducting time-variant filter, Proceedings of the IEEE, 58 (7).

81. Arnold, B. (1969), Surge protection in CATV amplifiers, 18th Annual NCTA Convention, Official Transcript.

82. Barnhart, A. (1970), Group delay variations of selected filter prototypes, Master Thesis, University of Pennsylvania, December.

83. Bell, R. and R. Clarke (1972), Elimination of cross-modulation in CATV amplifiers, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

84. Besse, L. (1969), Computerized wide band amplifier design, WESCON Technical Papers, Session No. 6-5.

85. Borremans, P. (1973), The use of low-gain amplifiers in large CATV Networks, Traction Et Electricite, Brussels, Belgium, September.

86. Carson, D. (1966), CATV amplifiers: figure of merit and the coefficient system, IEEE Transactions on Communication Technology, COM-14 (4), pp. 512-520.

87. Cauldwell, J. D. (1970), Two-way amplifiers, 19th Annual NCTA Convention, Official Transcript.

88. Community Antenna Television Journal (1974), Understanding the push-pull amplifier, August.

89. Dworkin, D. (1970), Analysis of a CATV amplifier performance vs. gain reduction, 19th Annual NCTA Convention, Official Transcript.

90. Dworkin, D. and T. Chuang (1970), A co-channel filter for CATV, Proceedings of the IEEE, 58 (7).

91. Eisenberg, J. (1972), How to specify wideband amplifiers for CATV, Microwaves, January.

92. Eschenback, R. (1970), Hybrid thin-film techniques applied to broadband cable communications repeater amplifiers, 19th Annual NCTA Convention, Official Transcript.

93. Gilbert, B. (1968), A new wide-band amplifier technique, IEEE Journal of Solid-State Circuits, SC-3.

94. Ginzton, E., W. Hewlett, J. Jasberg, and J. Noe (1948), Distributed amplification, Proceedings of the IRE, 36.

95. Hansell, G. (1969), Filter design and evaluation, Van Nostrand Reinhold Company.

96. Head, J. (1966), Resolving the conflict between amplitude and group delay requirements for certain types of low pass filter, BBC Research Department, Technical Report G101.

97. Hilling, A. and S. Salmon (1968), Intermodulation in common emitter transistor amplifiers, Electronic Engineering, 40.

98. Hoft, D. (1969), Design considerations for building high-frequency hybrid ICS, Electronic Equipment Engineering, May.

99. IEEE (1969), Investigation and evaluation of lightning protective methods for distribution circuits, Part II, Application and Evaluation, (IEEE Surge Protective Devices Committee of the IEEE Power Group), Papers No. 69TP92-PWR and No. 69TP91-PWR.

100. Jones, B. (1962), Cross-modulation in transistor amplifiers, Solid-State Design, 3, pp. 31-34.

101. Jones, B. (1966), A proposed quality factor for repeater amplifiers in CATV systems, TV Communications, March.

102. Jones, B., L. Besser, and N. Gri (1970), Computer aided design of a CATV amplifier using hybrid integrated circuits, 19th Annual NCTA Convention, Official Transcript.

103. Knauer, R. (1968), Intermodulation and crossmodulation in RF-amplifiers, Siemens Review, 35.

104. Kudsia, C. and N. Chitre (1969), Transmission and reflection group delay of Butterworth, Chebychev and elliptic filters, RCA Review, 30.

105. Lambert, W. (1970), Second-order distortion in CATV push-pull amplifiers, Proceedings of the IEEE, 58 (7).

106. Lambert, W. (1969), Design philosophy of broadband push-pull amplifiers, 18th Annual NCTA Convention, Official Transcript.

107. Lieberman, D. (1970), Diplexing of information in CATV amplifiers, 19th Annual NCTA Convention, Official Transcript.

108. Lieberman, D. (1970), Cross-modulation figure of merit for transistor amplifier stages, Proceedings of the IEEE, 58 (7).

109. Lotsch, H. (1961), Third-order distortion and cross modulation in a grounded emitter transistor amplifier, IEEE Transactions in Audio, AU-9, pp. 49-58.

110. Mallinckrodt, A. and F. Gardner (1963), Distortion in transistor amplifiers, IEEE Transactions on Electronic Devices, ED-10 (4).

111. McCaughey, O. and G. Rogeness, Erying Arrhenius is "One mean ...", but cool hand amp just shakes it off, boss, TV Communications, Parts I and II, June and July.

112. Narayan, S. (1967), Transistor distortion analysis using volterra series representation, BSTJ, 46.

113. Narayanan, S. (1969), Intermodulation distortion of cascaded transistors, IEEE Journal of Solid-State Circuits, SC-4.

114. Pennypacker, F. and E. DiLecce (1974), System considerations affecting antenna preamplifier design, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

115. Pranke, J. (1972), Power consumption: curbing the amp's appetite, TV Communications, February.

116. Rickel, J. (1970), Distribution amplifiers for the CATV studio, TV Communications, May.

117. Roeshot, L. (1969), A lossless transmission line, 18th Annual NCTA Convention, Official Transcript.

118. Roeshot, L. (1963), Distributed pair amplification, Electronic Design News, January.

119. Rogeness, G. (1974), Cable repeater station design using fixed gain block preamplifier and power amplifier, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

120. Rogeness, G. (1970), Two-way repeater station utilizing hybrid thin film amplifier as building block, 19th Annual NCTA Convention, Official Transcript.

121. Rogeness, G. (1969), CATV repeater amplifier design utilizing digital computer, 18th Annual NCTA Convention, Official Transcript.

122. Seidel, H., H. Beurrier, and A. Friedman (1968), Error-controlled high power linear amplifiers at VHF, BSTJ, May-June, pp. 651-722.

123. Shekel, J. (1973), On the realities of non-linear distortion in CATV amplifiers, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

124. Shekel, J. (1967), Output capability and gain, TV Communications, Volume 4, No. 1, January.

125. Simons, K. (1973), Relation between nonlinear distortion measurements and system performance, IEEE G-MTT International Microwave Symposium.

126. Simons, K. (1970), The optimum gain for a CATV line amplifier, Proceedings of the IEEE, 58 (7).

127. Simons, K. (1970), The decibel relationships between amplifier distortion products, Proceedings of the IEEE, 58 (7).

128. Thomas, L. (1968), Eliminating broadband distortion in transistor amplifiers, BSTJ, 47, pp. 315-342.

129. Tuil, J. (1968), Intermodulation in aerial amplifiers, Electronic Applications, 28, pp. 6-21.

130. Zelenz, M. (1970), On AGC transient-response behavior in cascaded amplifiers, Proceedings of the IEEE, 58 (7).

131. Zverev, A. (1967), Handbook of filter synthesis, John Wiley and Sons, New York, New York.

132. Arbuthnott, J. (1971), Dynafoam coax comes of age for CATV, 20th Annual NCTA Convention, Official Transcript.

133. Ashcroft, H., W. Clarke and J. Hinchliffe (1952), Some factors affecting the performance of coaxial cables for permanent television links, Proceedings of the IEE (London), 99, part 3A.

134. Barone, R. (1972), Simulated environmental aging of CATV cable, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

135. Blain, R. (1958), Buried wire and cable construction, Telephony, August 23, pp. 19-24, 60-61.

136. Blain, R. (1965), Gopher protection of buried cable plant, Telephony, April 14, pp. 12, 46, 48, 98.

137. Brubaker, K. (1970), Pressurization and the use of air dielectric cable, 19th Annual NCTA Convention, Official Transcript.

138. Cho, Y. (1972), Optimal equalization of wideband coaxial cable channels using "bump" equalizers, BSTJ, 51 (6).

139. Clarke, W. and J. Hinchliffe (1954), The evaluation of cable irregularities at very high frequencies, Proceedings of the IEE (London), Volume No. 101, part 4.

140. Connolly, R. and R. Landstrom (1969), Gopher damage to buried cable materials, Materials Research and Standards, 9 (12).

141. DeCoste, J. (1972), Effect of soil burial exposure on the properties of plastics for wire and cable, BSTJ, 9 (1).

142. Fan, J. and F. Spexarth (1970), Copper clad aluminum fine wire uses in coaxial cable, 19th Annual NCTA Convention, Official Transcript.

143. Fan, J. and F. Spexarth (1971), An analysis of CATV drop cable, TV Communications, June.

144. Fuchs, G. (1952), Reflections in a coaxial cable due to impedance irregularities, Proceedings of the IEE, 99, part 4, London.

145. Fuchs, G. and Y. Peltier (1964), The influence of small systematic impedance irregularities on VHF performance on coaxial cables, IEE Electronic Division Symposium, London.

146. Garrett, B. (1973), The design of expansion loops for reducing fatique in coaxial cable installations, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

147. Good, W. and T. Ritter (1971), Description and tests on impact welded cable splices, 20th Annual NCTA Convention, Official Transcript.

148. Halme, L. (1973), Use of magnetic materials to improve shielding, IEEE International Electromagnetic Compatibility Symposium.

149. Harris, J. (1969), Selecting conduit for your buried system, TV Communications, September.

150. Holland, J. (1969), Performance data on aluminum-sheathed drop cable, TV Communications, May.

151. Kirk, J., R. Brooks, and D. Saul (1970), Progress and pitfalls of rural buried plant, Telephone Engineering and Management, April.

152. Lee, R. (1972), Going straight with figure eight, TV Communications, September.

153. Lubars, H. and J. Olszewski (1968), Analysis of structural return loss in CATV coaxial cables, International Wire and Cable Symposium, December.

154. Miller, P. (1973), Test fixture and method - measuring shield effectiveness, Electrical Insulation Conference, pp. 357-359.

155. Naybour, R. (1973), Design criteria for reliable product, IEEE Transactions on Parts, Hybrids, and Packaging, March.

156. Olszewski, J. and H. Lubars (1970), Structural return loss phenomenon in coaxial cables, Proceedings of the IEEE, 58 (7).

157. Pierce, J. (1966), Information rate of a coaxial cable with various modulation systems, BSTJ, 45 (8).

158. Quackenbush, C. and E. Erison (1974), A coaxial connector design to overcome cold flow characteristics of cable meterials, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

159. Roberts, W. (1970), Comments on "Structural return loss phenomenon in coaxial cables," Proceedings of the IEEE 58 (7).

160. Roberts, W. (1968), Performance testing for CATV coax, TV Communications, August and September.

161. Roberts, W. and F. Wilkenloh (1970), Effects of nonuniform coaxial cable on CATV signal quality, 19th Annual NCTA Convention, Official Transcript.

162. Roemer, L. (1973), Reflected energy versus input pulse shape and obstacle size, IEEE Transactions on Instrumentation and Measurement, September.

163. Rollor, E. (1971), A new approach to dual cable construction, TV Communications, April.

164. Shiga, T. and Y. Inagaki (1969), Termite damage to cable and its prevention, Sumitome Electric Technical Review, March.

165. Simons, K. (1974), Testing coaxial cable for impedance periodicity, unpublished report available from the author at Jerrold Electronics Corporation, Hatboro, Pa.

166. Simons, K. (1972), A graphical method for relating coaxial cable attenuation measurements to theory, unpublished report available from the author at Jerrold Electronics Corporation, Hatboro, Pa.

167. Spexarth, F. (1973), Got those CATV drop cable picking blues again!, TV Communications, December.

168. Spexarth, F. and J. Fan (1971), Can coaxial cable cope with the CATV system of the '70's, 20th Annual NCTA Convention, Official Transcript.

169. Taj, H. (1973), Molded splicing system for underground distribution cables, Electrical Insulation Conference, pp. 131-134.

170. TV Communications (1972), Drop cable goes to seed so signals won't go to pot, December.

171. Whitmer, R. (1973), Effect of cable electrical length, connectors, and cracks in sheath, IEEE Transactions on Electromagnetic Compatibility, November.

172. Winston, E. (1973), A study of aluminum cable-connector interfaces and their effect on CATV system RF ingress, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

173. Witzigman, W. and L. Coggins (1970), An introduction to aluminum-sheathed coax, TV Communications, April.

174. Wood, J. (1970), Industry profile: systems wire and cable, TV communications, March.

175. Wright, J. (1972), The case for expansion loops, Broadcast Engineering, CE-2, November.

176. Adler, L. (1973), Two-way interactive systems, International Electrical, Electronics Conference and Exhibition, pp. 90-91.

177. Ameco, Inc. (1969), CATV cable installation handbook, Phoenix, Arizona.

178. ANPA Research Institute (1974), Ceefax and Oracle - a special report on electronic news distribution systems, Easton, Pa.

179. Arnold, B. (1973), Required system triple beat performance, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

180. Baer, W. (1971), Interactive television-prospects for two-way services on cable, Rand Report R-888-MF, Santa Monica, Calif.

181. Baran, P. (1975), Broadband interactive communication services to the home: II Impasse, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

182. Baran, P. (1971), Potential market demand for two-way information services to the home 1970-1990, Institute for the Future, Menlo Park, Calif., December.

183. Barksdale, B. (1973), Lightning and surge protection of CATV facilities, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

184. Barnhart, A. (1971), Two-way systems performance, 20th Annual NCTA Convention, Official Transcript.

185. Barnhart, A. (1972), Two-way CATV systems performance, IEEE Transactions on Broadcasting, BC-18 (1).

186. Begovich, N. (1970), The AML microwave link, 19th Annual NCTA Convention, Official Transcript.

187. Behringer, R. (1972), Blue sky to cash flow - market study, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

188. Belcher, B. (1972), Tocom system - functional specification, Tocom Inc., Box 47066, Dallas Texas.

189. Bell, R. and P. Rebeles, (1973), Third-order distortion build-up in a multi-channel cascade, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

190. Bell Telephone Laboratories (1970), Transmission systems for communications, 4th Edition, p. 103, Western Electric Co., Technical Publications, Winston-Salem, N.C.

191. Benson, B. (1973), Report on sources of variability in color reproduction as viewed on home TV receivers, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

192. Benson, B. (1973), Wide-screen scanning system for film-to-tape transfer, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

193. Bielawski, B. (1973), Optical Waveguides - future cable for CATV, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

194. Bilodeau, R. (1971), Design considerations for a modern CATV system, TV Communications, January.

195. Bilodeau, R. (1970), System grounding: an important protection, TV Communications, April.

196. Black, S. (1974), Cable television for Europe, U.S. Department of Commerce, Office of Telecommunications Report, OTP 74-28.

197. Blain, R. (1966), Engineering and Installing modern CATV systems, Telephony, April 9.

198. Blanchard, J. (1972), Flexicade - an evolutionary cable system, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

199. Blonder, H. and R. Greenhalgh (1974), IBM - Teleprompter digital transmission test satellite and CATV, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

200. Bordewijk, J. (1974), On the marriage of telephone and television, IEEE Transactions on Communications, to be published January, 1975.

201. Boyd, W. (1971), Santa Rosa cablevision: origination success story, TV Communications, November.

202. Braun, W. (1973), The case of the disappearing head room, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

203. Brayer, K. (1969), CADCOM: computer aided design for communications, Proceedings of the Symposium on Computer Processing in Communication.

204. Broadcast Management Engineering (1974), Automated information systems appear on cable TV scene at propitious time, CM/E - 4, July.

205. Broadcast Management Engineering (1974), Problems in Serving Urban Markets, Parts I and II, CM/E-5 and CM/E-7, February and March.

206. Broadcast Management Engineering (1972), Two-way TV haunted by technical goblins and financial fears, CM/E-3, June.

207. Broadcasting Publications Inc. (1974), Cable Sourcebook 1974, Washington, D.C.

208. Brooks, R. (1974), CATV system grounding techniques, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

209. Brothers, G. (1974), Design Considerations for two-way systems, Cable Communications, July.

210. Brownstein, G. (1971), Those extra channels could be hazardous, TV Communications, February.

211. Bryan, M. (1972), That new world of extras in technologically today, TV Communications, June.

212. Bryant, S. (1973), Economic model, IEEE Computer Society International Conference, pp. 89-92.

213. Buster, C. (1969), A challenge and a blueprint for a total telecommunication system, 18th International Wire and Cable Symposium.

214. Button, R. (1974), Cable and satellite, framework for a new industry, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

215. Cable Management Engineering (1971), Big city cable TV -- a tortuous labyrinth, BM/-E, April.

216. Callais, R. (1974), A progress report on field tests of the subscriber response system in El Segundo, Ca., Hughes Aircraft Company, Culver City, Ca., April.

217. Callais, R. (1972), SRS El Segundo interim test report, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

218. Campbell, J. and J. Gleason (1969), Design parameters for integrated urban communications, 18th Annual NCTA Convention, Official Transcript.

219. Campbell, L. (1973), The use of computers in CATV two-way communication systems, U.S. Department of Commerce, Office of Telecommunications Report, OTR 73-13, Volume 6.

220. Campbell, W. (1974), Controlling power system surges in cable television systems, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

221. Campbell, W. (1971), Locating and removing sources of power line interference, 20th Annual NCTA Convention, Official Transcript.

222. Canadian Cable Television Association (1971), The efficacy of Canadian cable television services, Ottawa, Canada.

223. Canadian Department of Communications (1974). Susceptibility of aeronautical receivers to CATV (mid-band) interferences, Engineering Report No. 1226.

224. Canadian Department of Communications (1974), A study of potential RF interference to aeronautical radio navigational aids, Technical Report BTRB-5, April.

225. Canadian Department of Communications (1971), Notes on DOC program for implementation of technical standards for cable television systems, March.

226. Canadian Radio-Television Commission (CRTC) (1972), Public announcement, Ottawa, March.

227. Canadian Radio-Television Commission (CRTC) (1971), The integration of cable television in the Canadian broadcasting system, February.

228. Cappon, J. (1971), Cable TV system calculator, 20th Annual NCTA Convention, Official Transcript.

229. Carne, E. (1972), Let's look realistically at telecommunications - 1985, Telephone Engineer and Management, December 1.

230. Cauldwell, J., P. Knight and E. Mertz (1969), RFI considerations in CATV, 18th Annual NCTA Convention, Official Transcript.

231. Chadwick, R., R. Gallawa and L. Wood (1973), Signal transmission and delivery between head-end and subscriber terminals, U. S. Department of Commerce, Office of Telecommunications Report, OTR 73-13, Volume 3.

232. Chadwick, R., and P. McManamon (1973), Advantages of digital transmission in CATV trunks, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

233. Chamberlain, K. (1972), Multipurpose frame grabbing interactive experiments, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

234. Chandler, D. (1971), Economically viable two-way systems are possible with time-division multiplexing, Electronics, September 27.

235. Chang, K. (1975), Intermodulation noise and products due to frequency-dependent nonlinearities in CATV systems, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

236. Chang, R. and S. Freeny (1968), Hybrid digital transmission systems, BSTJ, 47 (8).

237. Chipp, R. (1966), Community Antenna Television Systems, IEEE Spectrum, July.

238. Chuang, T. (1970), Multi-channel display and data communications, 19th Annual NCTA Convention, Official Transcript.

239. Clark, R. (1972), The domestic satellite characteristics and opportunities for cable TV, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

240. Codd, J. (1971), We will be operational by January 1974, Communications News, November.

241. Cohen, A., J. Beck, H. Seaman, H. Sullivan and S. Smithberg (1974), Subscription Television System, Lear Siegler Inc., Long Island City, New York.

242. Cohen, M. and R. Daly (1971), An optical link for CATV, 20th Annual NCTA Convention, Official Transcript.

243. Collins, C., and A. Williams (1962), Noise and intermodulation problems in multichannel closed-circuit television systems, Communications and Electronics, November.

244. Colodny, S. (1974), Thermal noise addition in collective systems, TV Communications, June.

245. Communications Publishing Corp. (1974) CATV directory of equipment, services, & manufacturers, Englewood, Colo.

246. Community Antenna Television Journal (1974), One-way alarm signaling, Oklahoma City, Oklahoma, August.

247. Community Antenna Television Journal (1974), Dead trunk vs second head-end, Oklahoma City, Oklahoma, August.

248. Community Antenna Television Journal (1974), Power lines, motors, lightning and trash, Oklahoma City, Oklahoma, May.

249. Connor, D., R. Brainard and J. Limb (1972), Intraframe coding for picture transmission, Proceedings of the IEEE, 60, No. 7.

250. Cooper, R. (1970), CATV System Maintenance, Tab Book, Blue Ridge Summit, Pa.

251. Cooper, R. (1966), CATV System Management and Operation, Blue Ridge Summit, Pa., Tab Books.

252. Coyne, J. (1974), An integrated broadband distribution system using demand assignment, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, to be published January 1975.

253. Crusan, J. (1972), Second order distortion -- a problem of the first order, TV Communications, June.

254. Cummings, D. and G. Dixon (1972), Considerations for transient and surge protection in CATV systems, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

255. Cummings, D. (1970), Infrared and optical links for CATV, 19th Annual NCTA Convention, Official Transcript.

256. Dattner, R. and J. Shekel (1974), Bending your system into shape, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

257. Dent, G. (1972), Build your own handy-dandy system construction computer, TV Communications, March.

258. DeWitt, R. (1971), Nationwide digital transmission network for data, Telecommunications, Volume 5, No. 9.

259. Dixon, G. (1970), The use of modulated pilots in ALC systems, 19th Annual NCTA Convention, Official Transcript.

260. Dixon, G. (1968), Design notes on CATV systems with Novacor equipment, C-Cor Electronics, Inc., State College, Pa.

261. Dixon, G. (1969), Temperature and the CATV system, 18th Annual NCTA Convention, Official Transcript.

262. Dixon, J. (1973), RF interference problem, IEEE Southeast Conference J3.1-J1.5.

263. Dixon, J. (1972), The real work of two-way, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

264. Dolberg, C. (1972), Digital cable communications, The MITRE Corp M71-113, Bedford, Mass.

265. Dryan, M. and P. Maxwell (1972), Cable communications: a new world of extras, TV Communications, June.

266. Durfee, E. and R. Callais (1971), The subscriber response system, 20th Annual NCTA Convention, Official Transcript.

267. Dworkin, D. (1968), Signal-to-noise calculator for system design, TV Communications, July.

268. Edelman, S. (1971), Cable communications: the Los Gatos experiment, The Electronic Engineer, June.

269. Eldridge, F. (1972), Automatic meter reading via cable, The MITRE Corp. M72-67, McLean, Va.

270. Eldridge, F. (1972), Privacy for cable services, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

271. Eldridge, F. (1972), Privacy need not be a double-think concept, TV Communications, September.

272. Electronic Industrial Engineering, Inc. (1973), A computer controlled, bidirectional communication system, North Hollywood, California.

273. Electronics (1971), Stringing the wired city: two-way TV descends from the blue sky to the real world, September 27.

274. Electronics Review (1971), Cable TV men agree on wired city, Electronics, 44 (15).

275. Eller, T. (1974), Terminal Devices for interactive television systems and their impact on services, IEEE Intercon Technical Papers, International Convention and Exposition, March 26-29.

276. Feldman, N. (1973), System designs for the Dayton metropolitan Area, IEEE Transactions on Broadcasting, March.

277. Feldman, N. (1970), A scenario for the future of cable television distribution, Proceedings of the IEEE International Convention Digest, March.

278. Fink, D., editor (1943), Television Standards and Practices, McGraw-Hill, New York.

279. Firestone, M. (1970), Broadcasters look at CATV and a response, 19th Annual NCTA Convention, Official Transcript.

280. Forbes, D. and C. Cooley (1973), The Magnavox premium T V System, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

281. Frisch, I. (1975), Technical problems in nationwide networking and interconnection, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

282. Frisch, I. (1972), Stranded in the map maze? A computerized way out, TV Communications, February.

283. Frisch, I., W. Rothfarb and A. Kershenbaum (1972), Reliability through total automation of CATV system design, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

284. Frisch, I., W. Rothfarb and A. Kershenbaum (1971), A computer design of CATV distribution systems, 20th Annual NCTA Convention, Official Transcript.

285. Gabriel, R. (1975), Cable systems for Great Britain, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

286. Gabriel, R. (1970), Dial a program -- an HF remote selection cable television system, Proceedings of the IEEE, 58 (7).

287. Gabriel, R. (1967), Wired broadcasting in Great Britain, IEEE Spectrum, 4, pp. 97-105.

288. Gallawa, R. (1975), Optical Communications Technology, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

289. Gibson, J. (1973), Accumulation of noise and intermodulation distortion in two-way cable television systems, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

290. Goldmark, P. (1972), National cable systems, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

291. Gourley, D. (1972), Data communications: initial planning, Datamation, pp. 59-64.

292. Greenberg, E. (1970), Wired-city television revisited, Proceedings of the IEEE, 58 (7).

293. Gregory, D. (1969), AGC operation and system performance, 18th Annual NCTA Convention, Official Transcript.

294. Gushman, P. (1973), Tomorrowland's pay cable moves to adventureland, TV Communications, July.

295. Guthrie, E., and F. Ivanek (1971), An all solid-state SSB-AM CARS band system, 20th Annual NCTA Convention, Official Transcript.

296. Hale, J. (1974), Status Monitoring System, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

297. Hamlin, P. (1974), The ideal tap: designed by the user, of course, TV Communications, August.

298. Hamlin, P. (1972), Cable around the world -- Part II, TV Communications, July.

299. Hamsher, D. (1967), Communication system engineering handbook, McGraw-Hill Book Company, New York.

300. Hara, E. (1974), Optical communications and the future of cable television, Canadian Department of Communications, Ottawa, Canada.

301. Hare, A. (1975), Multi-purpose wideband local distribution -- proposals for an integrated system, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

302. Harr, T., E. Haakinson and S. Murahata (1974), Electromagnetic compatibility of simulated CATV signals and aircraft navigation receivers, U. S. Department of Commerce, Office of Telecommunications Report, OTR 74-39, June.

303. Harrer, J. (1971), Level control for multichannel and two-way systems, 20th Annual NCTA Convention, Official Transcript.

304. Haskell, B., F. Mounts and J. Candy (1972), Interframe coding of video-telephone pictures, Proceedings of the IEEE, 60, No. 7.

305. Hauser, W. (1969), Problems and solutions in buried CATV plant, 18th Annual NCTA Convention, Official Transcript.

306. Head, H. and N. Penwell (1971), Sources of degradation in the overall television system, A. D. Ring & Associates, Washington, D.C., January.

307. Herold, E. (1970), A compatible high-resolution TV system for cablecasting, Proceedings of the IEEE, 58, (7)

308. Hickman, J. and G. Kleykamp (1971), Multicable solution to communications systems problems, IEEE Convention, March.

309. Hirshfield, J. and A. Leufev (1970), Expanding to 17 channels; a practical approach, TV Communications, September.

310. Hoth, D. (1975), Broadband media for urban communications, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

311. Humphreys, J. and R. Weiblen (1972), Discable -- a new automatic sound and view programming system for CATV, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

312. Huntoon, Z. and G. Cohen (1974), Estimating CATV demand patterns for system development, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

313. IEEE Spectrum (1971), Network optimization for two-way CATV system design is programmed on a computer in new product applications, 8 (11), 82.

314. IEEE Transactions on Communications (1975), Special Issue on Interactive Broadband Cable Systems, January.

315. Jackson Communications (1972), Building a system -- so, who is going to do the work?, Dayton, Ohio.

316. James, R. (1965), Data transmission -- the art of moving information, IEEE Spectrum, January.

317. Jansky & Bailey Broadcast - Television Department (1970), Current CATV technical topics: a compendium, Atlantic Research Corp., Washington, D.C.

318. Jansky & Bailey Telecommunications Consulting Dept. (1971), Engineering report on the development of a cable television system for Washington, D. C., Volumes I and II, Atlantic Research Corporation, Washington, D.C.

319. Jeffers, M. (1974), Two-way transmission in CATV systems, IEEE Intercon Technical Papers, International Convention and Exposition, March 26-29, 1974.

320. Jeffers, M. (1970), Best frequency assignments for mid and super band channels, 19th Annual NCTA Convention, Official Transcript.

321. Johnson, D. (1972), CATV and microwave networks of the future, Western Tele-communications, Inc., September, pp. 1-10.

322. Johnson, J. (1969), CARS band microwave: a primer for cablemen, TV Communications, November.

323. Jurgen, R. (1971), Two-way applications for cable television systems in the '70s, IEEE Spectrum, pp. 39-54.

324. Katz, H. (1974), Industrial two-way CATV systems, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

325. King, P. (1973), A novel TV add-on data communication system, Hazeltine Research, Inc., Chicago, Ill.

326. Kirk, D. and M. Paolini (1971), PCM subchannels for video microwave, 20th Annual NCTA Convention, Official Transcript.

327. Kirk, D. and M. Paolini (1970), A digital video system for the CATV industry, Proceedings of the IEEE, 58 (7).

328. Labonté, R. (1973), Digital communications via cable TV network, IEEE Computer Society International Conference. 85-88.

329. Labonté, R., and A. Marguites (1971), Urban mobile communications and vehicle location via broadband cable networks, The MITRE Corporation, M71-110, Bedford, Mass., December.

330. Lambert, W. (1971), Two-way CATV, Terwood Laboratory, Jerrold Electronics Corporation, Horsham, Pa.

331. Ledbetter, T. and G. Mendelson (1972), The wired city: a handbook on cable television for local officials, Urban Communications Group, Washington, D.C.

332. Leisch, J. (1969), Transportation systems in the future development of metropolitan areas: the permanent corridor concept, Highway Research Board Record, No. 293, Washington, D. C.

333. Lerner, H. and T. Moriarty (1969), Cities and cable television, Nations Cities, August.

334. Levine, N. (1972), The dilemma of mixed systems, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

335. Lieberman, D. (1971), Cascading of inter-modulation distortion in cable television systems, 20th Annual NCTA Convention, Official Transcript.

336. Lieberman, D. (1970), Wide spectrum services: CATV and the future, TV Communications, June.

337. Lieberman, D. (1970), Diplexing of information in CATV amplifiers, 19th Annual NCTA Convention, Official Transcript.

338. Lieberman, D. (1969), Bi-directional transmission methods for cable television, TV Communications, January.

339. Long, J. (1971), Maintenance of large CATV Systems, 20th Annual NCTA Convention, Official Transcript.

340. Maeda, K. (1975), A two-way broadband CATV system and its application to individualized still-picture communication, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

341. Malarkey, Taylor, and Associates (1971), Pilot projects for the broadband communications distribution system, November, Available NTIS, PE-208913.

342. Marron, H. (1973), Crosstalk and isolation requirements in dual trunk systems, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

343. Marron, H. and L. Farber (1972), Return system AGC in two-way CATV systems, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

344. Marron, H. and A. Barnhart (1970), System considerations in the design of a two-way transmissions system, 19th Annual NCTA Convention, Official Transcript.

345. Marrow, H. (1973), Crosstalk and isolation requirements in dual trunk systems, Cablecasting, September/October.

346. Marsten, R. (1972), The ATS-F satellite experiment with cable TV distribution, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

347. Martin, J. (1971), Future developments in telecommunications, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

348. Mason, W. and S. Polk (1972), Premium TV to get real test in 1972, Cable Management Engineering, February.

349. Mason, W. (1971), The full exploitation of the wired city's potential requires a systems approach, Electronics, 44 (20).

350. Mason, W. (1971), Urban cable systems, the MITRE Corporation, M71-64, McLean, Va.

351. Matney, J. (1972), Some descriptive models of single facility sequencing with interactive service times, the MITRE Corporation M72-22, Ph.D. Thesis, the Ohio State University, 1971.

352. Matthews, J. (1970), Cablecasting -- an insatiable appetite, 19th Annual NCTA Convention, Official Transcript.

353. Maxwell, P. (1972), Urban cable development: we shall overcome, TV Communications, March.

354. Mays, J. (1970), The development and evaluation of an ultra-high resolution television system, Final Report, Systems Research Labs., Dayton, Ohio, AD-885826L.

355. McCaughey, O. and G. Rogeness (1973), Destructive corrosion in CATV distribution system equipment, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

356. McGrory, G. (1972), Underground costs and installation trade-offs, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

357. McManamon, P. (1973), System interconnections, U.S. Department of Commerce, Office of Telecommunications Report, OTR 73-13, Volume 5.

358. Merrel, R. (1971), 1971 automation review, Broadcast Engineering, 18, (6), 20-26.

359. Millar, J., R. Gutmann, and K. Rose (1974), Methods for supplying interactive services on broadband communication networks, IEEE Transactions on Communications, to be published January, 1975.

360. Millard, J. and J. Maunsell (1971), Digital encoding of the video signal, BSTJ, 50, No. 2.

361. Milne, D. (1972), The multipoint distribution service - a threat or a promise, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

362. Moon, G. (1972), Reliability and maintenance of total underground systems, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

363. Mounts, F. (1969), A video encoding system employing conditional picture element replenishment, BSTJ. 48 (7).

364. Mumford, W. (1968), Noise performance factors in communication systems, Monograph published by Horizon House - Microwave, Inc., Dedham, Massachusetts.

365. Nash, G. (1970), Phase-locked loop design fundamentals, Application Note AN-535, Motorola Semiconductor Products, Inc., Phoenix, Arizona.

366. National Academy of Engineering (1971), Communications technology for urban improvement, Committee on Telecommunications, Washington, D.C.

367. National Cable Television Association (1974), 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

368. National Cable Television Association (1973), 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

369. National Cable Television Association (1972), 21st Annual NCTA Convention, Official Transcript, Technical Volume.

370. National Cable Television Association (1971), 20th Annual NCTA Convention, Official Transcript.

371. National Cable Television Association (1970), 19th Annual NCTA Convention, Official Transcript.

372. National Cable Television Association (1969), 18th Annual NCTA Convention, Official Transcript.

373. Naugle, R. (1970), CARS band frequency conservation, 19th Annual NCTA Convention, Official Transcript.

374. New, L. (1972), A documentation process for CATV systems, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

375. Nicholson, V. (1974), Rural extension techniques and systems, 23rd NCTA Convention, Official Transcript, Technical Volume.

376. Norback, J. (1970), Concepts for cable transmission systems, 18th International Wire and Cable Symposium, Communication News, February.

377. O'Connor, R. (1973), The JCIC ad hoc committee on TV broadcast ancillary signals -- why it was established, and what it expects to accomplish, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

378. O'Neill, J. (1972), CATV's critical mass problem, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

379. Osborne, W. (1971), A bi-directional cable television information and control transmission system, 20th Annual NCTA Convention, Official Transcript.

380. Page, O. (1969), CATV transmission system design for reliable year-round operation, IEEE Transactions on Broadcasting, December.

381. Page, O. and P. Treynor (1970), Dual pulsed-pilot carrier ALC for temperature color stability of CATV signals, 19th Annual NCTA Convention, Official Transcript.

382. Palmer, J. (1968), Control for CATV temperature, temperature design and AGC, TV Communications, May.

383. Palmer, J. (1967), CATV systems design philosophy and performance criteria as the basis for specifying equipment components, IEEE Transactions on Broadcasting, BC-13, pp. 57-68.

384. Paolini, M. and D. Kirk (1970), Digital video techniques, 19th Annual NCTA Convention, Official Transcript.

385. Paquette, C. (1971), Summary of D.C. government cable survey, the MITRE Corporation, WP-8564, Washington, D.C., December.

386. Park, R. (1971), Prospects for cable in the 100 largest television markets, Rand Corporation, Report R-875 MF, Santa Monica, Calif., October.

387. Pauley, D. (1972), Automation of transmitting system, IEEE Transactions on Broadcasting, BC-18 (2).

388. Pease, R. (1972), Conditional vertical subsampling -- a technique to assist in the coding of television signals, BSTJ, 51, (4).

389. Pease, R. and J. Limb (1971), A simple interframe coder for video telephony, BSTJ, 50, (6).

390. Pedelty, M. (1973), Two-way systems in urban areas, IEEE Decision and Control Conference.

391. Petit, R. (1973), An analysis of proven pay CATV systems, 22nd NCTA Convention, Official Transcript, Technical Volume.

392. Pettit, J. and D. Grace (1970), The Stanford instructional television network, IEEE Spectrum, 7.

393. Pilnick, C. (1972), Cable television: technical considerations in franchising major market systems, The Rand Corporation, Santa Monica, Calif., August.

394. Ports, D. (1975), Trends in cable TV, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

395. Ports, D. (1973), Domestic satellite/cable decision factors, Condensed Text of Presentation at CATV Satellite Access Entity Meeting, Chicago, Ill., August 2.

396. Powers, R. (1975), Broadband Systems Standards, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

397. Powers, R. (1972), Channel allocation options, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

398. Powers, R. (1972), Channels, channels...and more channels -- cable television headache no. 3/31/72-80, TV Communications, August.

399. Pyes, N. (1972), Planning a data communications system, Datamation 18 (11), pp. 74-80.

400. Reeve, J. (1972), Engineering paper on the development of a cable television system for Washington, D.C., Annual Meeting of IEEE Professional Group on Broadcasting, September 21-22, 1972.

401. Reiter, A. (1971), Ende-code television signal encoding and decoding for cable systems, 20th Annual NCTA Convention, Official Transcript.

402. Rheinfelder, W. (1970), CATV System Engineering, 3rd Ed., Tab Books, Blue Ridge Summit, Pa.

403. Rodriguez, M. (1970), Design considerations for two-way transmission, TV Communications, December, November, and October.

404. Roeshot, L. (1970), The use of integrated circuits in cable television, 19th Annual NCTA Convention, Official Transcript.

405. Rogeness, G. (1972), Contributing sources and magnitudes of envelope delay in cable transmission system components, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

406. Rogeness, G. (1971), Match repeater amplifier performance characteristics to cable system level requirements, 20th Annual NCTA Convention, Official Transcript.

407. Rogeness, G. (1968), Two-way transmission on the CATV cable, 17th Annual NCTA Convention, Official Transcript.

408. Rogeness, G. (1965), Envelope delay in CATV systems, TV Communications, October.

409. Rose, K. (1975), Design of a switched broadband communications network for interactive services, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

410. Rosner, I. (1971), Television broadcasting and the wired city, IEEE Transactions on Broadcasting, BC-17 (2).

411. Roth, E. (1973), Cable television manpower: job descriptions and educational requirements, U.S. Department of Commerce, Office of Telecommunications Report OTR-73-2, February.

412. Roth, M. (1971), Security-alert -- a two-way digital communications system, 20th Annual NCTA Convention, Official Transcript.

413. Rubin, P. (1974), A quantitative comparison of the relative performance of VHF and UHF broadcast systems, Corporation for Public Broadcasting, Washington, D.C., June.

414. St. Louis, R. (1970), Improving reliability of CATV systems, 19th Annual NCTA Convention, Official Transcript.

415. Sampson, C. (1973), Mutual interference effects in data/CATV systems, 22nd NCTA Convention, Official Transcript, Technical Volume.

416. Sampson, C. (1970), Design considerations for a closed-loop CATV system, 19th Annual NCTA Convention, Official Transcript.

417. Schlafly, H. (1974), Electronic Communications Trends, TV Communications, May.

418. Schlafly, J. (1967), 18 GHz wideband distribution system propagation test, IEEE International Convention Record, Part 2.

419. Schoenback, R. (1972), Design aspects of bidirectional cable systems, Electronic Industrial Engineering, Inc., North Hollywood, Calif.

420. Schreiber, W. (1958), TV bandwidth reduction by digital coding, IRE Convention Record, Part 4.

421. Schwartz, P. (1971), A practical approach to bi-directional systems, 20th Annual NCTA Convention, Official Transcript.

422. Seyler, A. (1965), Probability distribution of TV frame differences, Proceedings of the IREE, Australia, 26 (11).

423. Seyler, A. (1962), The coding of visual signals to reduce channel-capacity requirements, Proceedings of the IEE, 109C (15).

424. Shafer, E. (1971), CATV systems as common carriers, 20th Annual NCTA Convention, Official Transcript.

425. Shapiro, P. (1972), Cable may just tie this country together yet, TV Communications, November.

426. Shapiro, P. (1972), Networking in cable television: analysis of present practices and future alternatives, Institute for Communication Research, Stanford University.

427. Shekel, J. (1970), Frequency band assignments free of second-order beat interference, Proceedings of the IEEE, 58 (7).

428. Shepherd, B. (1974), An economic model: pay-cable's return on investment, TV Communications, January.

429. Simons, K. (1974), Shielding in CATV systems, Jerrold Electronics Corporation, Horsham, Pa., unpublished paper available from author.

430. Simons, K. (1972), Not all in-band beats are eliminated by locking carrier spacing to 6 MHz, IEEE Cable Communications Coordinating Committee, February 15.

431. Smith, E. (1975), Pilot two-way CATV systems, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

432. Smith, H. (1973), Utility grounding practices, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

433. Sonnenschein, A. (1972), Performance of multi-channel microwave local distribution systems, 21st Annual NCTA Convention, Official Transcript.

434. Sorenson, K. (1973), If I can get it in my hotel -- why can't I have it in my house?, TV Communications, June.

435. Spearen, T. (1972), Multi-channel CARS band distribution using standard FM microwave equipment, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

436. Spradlin, P. (1969), A review of taps for CATV, 18th Annual NCTA Convention, Official Transcript.

437. Stetten, K. (1971), TICCIT: a delivery system designed for mass utilization, M71-56, The MITRE Corp., October.

438. Stetten, K. and W. Mason (1971), A low cost interactive home TV terminal, 20th Annual NCTA Convention, Official Transcript.

439. Stine, L., C. Plummer, and M. Lambert (1971), Local distribution of telecommunications: a perspective, the MITRE Corp., M71-91, August.

440. Swanson, T. and J. Bird (1972), Highlights - underground construction techniques, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

441. Swatz, L. and K. Smith (1969), Computer aided engineering of cable carrier systems, Lenkurt Electric Company.

442. Swenson, R. and D. Lipke (1973), The effects of satellites on CATV, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

443. Swires, C. (1974), Two-way cable TV systems, Cable Television Engineering, Vol. 10, No. 3, April.

444. Switzer, I. (1975), A harmonic carrier system for cable television, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

445. Switzer, I. (1973), Reduction of co-channel interference by use of precision frequency control in the originating transmitters, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

446. Switzer, I. (1972), Coherent carrier for CATV - state of the art, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

447. Switzer, I. (1971), The rediffusion dial-a-program system, TV Communications, April.

448. Switzer, I. (1971), Phase lock application salvages local channels, TV Communications, July.

449. Switzer, I. (1970), Toward the expansion of cable capability, TV Communications, June and July.

450. Switzer, I. (1970), Cable amplifier powering methods, 19th Annual NCTA Convention, Official Transcript.

451. Tanner, R. (1975), On man's needs for communication, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

452. Taylor, A. (1969), On-channel carriage of local TV stations on CATV, IEEE Transactions on Broadcasting, December.

453. Teleng Limited (undated), Teleng 2 way demonstration system, South Ockendon, Essex, Great Britain.

454. Television Digest Inc. (1974), Television factbook, No. 43, 'Stations' and 'Services' volumes, Washington, D.C.

455. Theile, R. (1966), European modulation methods, IEEE Spectrum, June, pp. 61-68.

456. Thomas, J. (1971), I am curious (cablecasting), 20th Annual NCTA Convention, Official Transcript.

457. Towle, G. (1973), An overview of cable television two-way communications as ancillary services with emphasis on software development and market availability, B A mini-thesis, North Texas State University.

458. TV Communications (1971), CATV networking studied, August, p. 70.

459. TV Communications (1974), CATV directory of equipment, services, & manufacturers, Communications Publishing Corp., Englewood, Colorado.

460. TV Communications (1971), Master-planned CATV for a master-planned city, May.

461. TV Communications (1970), Construction projects: the critical path to success, May.

462. TV Communications (1970), Underground construction:time for your best PR, April.

463. Vicom Manufacturing Company (1971), Interaction Television, Ann Arbor, Michigan.

464. Vogelman, J. and I. Kamen (1970), Filtered pulse width modulation (FPWM) for inter and intra city distribution, 19th Annual NCTA Convention, Official Transcript.

465. Vogelman, J. and M. Reader (1972), Modulation index and transmitter power relationship in multiple channel TV FM systems, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

466. Volk, J. (1971), The Reston, Virginia test of the MITRE Corporation's interactive television system, The MITRE Corp., MTP-352, Washington, D.C., May.

467. Walker, G. (1971), Stringing the wired city: two-way TV descends from blue sky to real world, Electronics, September.

468. Walters, R. (1973), Financial success in today's metropolitan CATV markets, Theta-com of California, Phoenix, Arizona.

469. Ward, J. (1972), What belongs on the cable, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

470. Weiss, M. (1969), Solving temperature problem using dual carrier automatic slope and gain (ASG) controls, 18th Annual NCTA Convention, Official Transcript.

471. Wilson, R. (1973), Consideration for reverse signals in the feeder lines, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

472. Woods, N. (1974), An economic model of the selection process: microwave versus conventional techniques in CATV distribution, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

473. Worth, N. (1974), Can CATV sub-low return systems be made to work?, Cablecasting, June.

474. Yu, J. and W. Wilhelm (1971), Optimization of urban transportation terminal network, Highway Research Board, Washington, D.C.

475. Zimmerman, A. and I. Switzer (1970), System improvement via phase locked signals, 19th Annual NCTA Convention, Official Transcript.

476. Anderson, R. (1973), So, you're finally going to buy some new test gear?, TV Communications, February.

477. Avantek, Inc. (1972), Operational Manual, remote automatic sweep system, CT-1000 Cable Transmitter and CR-1000 Cable Receiver, Santa Clara, Calif., June.

478. Ball, J. and E. Whetmore (1973), The key aspects of signal-to-noise in television viewing, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

479. Barstow, J. and H. Christopher (1962), The measurement of random video interference to monochrome and color television, AIEE Transactions C&E, 63, pp. 313-320.

480. Barstow, J. and H. Christopher (1954), The measurement of random monochrome video interference, AIEE Transactions C&E, 73, pp. 735-741.

481. Behrend, W. (1956), Reduction of co-channel television interference by precise frequency control of television picture carriers, RCA Review, 17, p. 443.

482. Bell, L. (1970), Digital concepts, Tektronix, Inc., Beaverton, Oregon, December.

483. Bilodeau, R. (1970), A technique for testing, TV Communications, December.

484. Bilodeau, R. (1970), Using the FSM in system performance testing, TV Communications, August.

485. Bilodeau, R. (1970), System performance testing: using the field strength meter, TV Communications, February.

486. Biro, S. and F. Schulz (1972), Co-channel measurement: state-of-the-art report, TV Communications, January.

487. Braun, W. (1970), Frequency measurement methods, 19th Annual NCTA Convention, Official Transcript.

488. Chapin, E. (1956), UHF field intensity measurement experience, IRE Transactions on Broadcast Transmission Systems, PGBTS-3, January.

489. Chapin, E., L. Middlekamp, and W. Roberts (1958), Co-channel television interference and its reduction, IRE Transactions on Broadcast Transmission Systems, PGBTS-10.

490. Community Antenna Television Journal (1974), True meaning of signal to noise ratios, Oklahoma City, Okla., June.

491. Community Antenna Television Journal (1974), RFI -- Radio frequency interference, Oklahoma City, Okla., May.

492. Cowart, R. and R. Anderson (1973), Scan loss and its elimination in CATV swept frequency measurements, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

493. Crusan, J. (1972), CATV distortion measurement techniques, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

494. Dean, C. (1960), Measurements of the subjective effects of interference in television reception, Proceedings of the IRE, 48, pp. 1035-1041.

495. Dixon, G. and T. Kenly (1971), Specialized test equipment for CATV distribution measurements, 20th Annual NCTA Convention, Official Transcript.

496. Dolan, L. (1973), A meter is a meter is a meter -- or is it?, TV Communications, April.

497. Douglas, R. (1972), Field strength monitors - a unique test instrument for CATV, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

498. Fogle, J. and S. Kempinski (1971), Calibration of cross modulation measurements, 20th Annual NCTA Convention, Official Transcript.

499. Fowler, A. (1957), Observer reaction to video crosstalk, Journal of SMPTE, New York, 57, pp. 416-424.

500. Fowler, A. (1951), Observer reaction to low frequency interference in television pictures, Proceedings of the IRE, October, pp. 1332-1336.

501. Fredendall, G. and W. Behrend (1960), Picture quality procedures for evaluating subjective effects of interference, Proceedings of the IRE, 48 (6), pp. 1030-1034.

502. Geissler, R. (1974), CATV system measurements -- Antenna terminals to subscriber's tap, Vitek Electronics, Inc., Middlesex, New Jersey.

503. Gluyas, T. and W. Behrend (1968), Correlation between TV transmitter performance measurements and picture quality, IEEE Transactions on Broadcasting, BC-14 (1).

504. Grant, W. (1973), Two-way cable is no place for wrong-way corrigan, TV Communications, May.

505. Gumm, L. (1972), Key frequency parameter measurements and instruments, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

506. Gumm, L. (1972), Spectrum analysis and key FCC measurements, TV Communications, October and November.

507. Hale, J., C. Schrock, and J. Dolan (1972), Measuring CATV performance for the good old FCC, Cable Tech, November.

508. Hale, J., C. Schrock, and J. Dolan (1972), Complying with the FCC: are you up to the test?, TV Communications, 9, December.

509. Hand, W. (1970), Measurement of receiver phase characteristics, IEEE Transactions on Broadcast and Television Receivers, BTR-16 (4), p. 290.

510. Hewlett-Packard (1974), Application Note 150, Spectrum analysis -- spectrum analyzer basics, April.

511. Hewlett-Packard (1971), Application Note 150-1, Spectrum analysis -- amplitude and frequency modulation, November.

512. Hewlett-Packard (1971), Application Note 150-2, Spectrum analysis -- pulsed RF, November.

513. Hewlett-Packard (1974), Application Note 150-3, Spectrum analysis -- swept frequency measurements and

selective frequency counting with a tracking generator, February.

514. Hewlett-Packard (1974), Application Note 150-4, Spectrum analysis -- noise measurements, April.

515. Hewlett-Packard (1973), Application Note 250-5, Spectrum analysis -- CRT photography and X-Y recording techniques, May.

516. Hewlett-Packard (1974), Application Note 150-6, Spectrum analysis -- CATV proof of performance, April.

517. Hewlett-Packard (1972), Spectrum Analyzer Measurement Seminar, May.

518. Hewlett-Packard (1968), Application Note 95, S-parameters, September, pp. 1-12.

519. IEEE Proceedings (1967), Radio measurement methods and standards, Proceedings of the IEEE, 55 (6), entire issue.

520. IEEE Proceedings (1969), Standards for measuring field strength, No. 302, August.

521. Johannesen, F. (1967), Recent developments and utilizations of test signals in the vertical interval, IEEE Transactions on Broadcasting, BC-13, pp. 6-13.

522. Johannesen, F. (1965), The performance requirements of a television monitor receiver (Nyquist demodulator) and methods of measurement, The Radio and Electronic Engineer, 30 (3), pp. 175-191.

523. Lee, R. (1972), Test equipment update: has management learned anything?, TV Communications, December.

524. Levenson, D. (1969), New technique permits summation sweeps without interruption of CATV subscriber service, IEEE Transactions on Broadcasting, BC-15, No. 4, December.

525. Lowe, R. (1969), TDR - Theory and cable fault locating, 18th Annual NCTA Convention, Official Transcript.

526. Marvin, L. (1973), Determining radiation levels in CATV cable systems for compliance with FCC regulations, 22nd

Annual NCTA Convention, Official Transcript, Technical Volume.

527. McKeown, M. (1974), CATV proof of performance testing, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

528. Osborne, B. (1970), Waveform testing of television broadcast or cable transmissions by means of demodulated VIT signals, 19th Annual NCTA Convention, Official Transcript.

529. Osborne, B. (1970), Color television signal demodulation and the K-rating, Proceedings of the IEEE, 58 (7).

530. Osborne, B., A. Peverett, and D. Wallace (1964), The K-rating of television equipment and networks, Television Society Journal, Vol. 10, pp. 294-299.

531. Panter, P. (1965), Modulation, noise and spectral analysis, McGraw-Hill, New York, New York.

532. Penwell, N. (1972), Critical steps to compliance, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

533. Ports, D. and W. Hsiao (1974), Signal leakage and interference control, NCTA Engineering Manual, National Cable Television Association, Washington, D.C., October.

534. Ports, D. and W. Hsiao (1974), Signal leakage and the March 31, 1974 testing deadline, NCTA Technical Topics, National Cable Television Association, Washington, D.C.

535. Ports, D. and W. Hsiao (1973), The FCC report and order amending certain performance tests and technical standards for cable television systems, NCTA Technical Topics, National Cable Television Association, Washington, D.C.

536. Pranke, J., B. Henscheid, and T. Straus (1974), A new approach to evaluating CATV system triple beat performance, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

537. Ragone, F. (1969), Performance measurements of modulators and demodulators for CATV, IEEE Transactions on Broadcasting, Vol. BC-15, No. 4, December.

538. Regent, R. (1972), Troubleshooting with unwanted signals, Broadcast Engineering, March.

539. Rhodes, C. (1969), Measurement of nonlinear distortions in NTSC color television, Proceedings of NAB Conference, pp. 218-228.

540. Rhodes, C. (1972), The 12.5T modulated sine-squared pulse for NTSC, IEEE Transactions on Broadcasting, BC-18 (1).

541. Rhodes, C. (1971), Measuring interference without subscriber noise, TV Communications, December.

542. Rhodes, C. (1971), In-service noise measurements on a CATV system, 20th Annual NCTA Convention, Official Transcript.

543. Rickel, J. (1971), The ABC's of reading video waveform monitors, TV Communications, April.

544. Rickel, J. (1970), The waveform monitor and picture quality control, TV Communications, March.

545. Rickel, J. (1971), Test equipment for your origination system, TV Communications, February.

546. Rickel, J. (1970), Meet the sync generator: heart of originations, TV Communications, June.

547. Roberts, W. (1968), Performance testing for CATV coax, TV Communications, September and August.

548. Schmid, H. (1969), How to determine the 2T pulse K factor of TV facilities without the aid of an oscilloscope graticule, IEEE Transactions on Broadcasting, BC-15, pp. 12-14.

549. Schmid, H. (1968), Measurement of television picture impairments caused by linear distortions, SMPTE Journal, March.

550. Schrock, B. (1974), Validity of subjective testing, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

551. Schrock, B. (1973), No loose ends -- The Tektronix proof-of-performance program for CATV, Tektronix, Inc., Beaverton, Oregon, June.

552. Schulz, F. (1967), Characteristics of field strength meters, TV Communications, June.

553. Schulz, F. (1971), Envelope delay, phase delay, group delay, chroma delay, what does it mean, how is it measured, 20th Annual NCTA Convention, Official Transcript.

554. Schulz, F. (1970), Signal level meter calibration techniques, 19th Annual NCTA Convention, Official Transcript.

555. Scientific-Atlanta, Inc. (1971), Security-alert: An essential part of a broadband two-way cable system, Atlanta, Georgia, September.

556. Selby, M. (1967), Voltage measurement at high and microwave frequencies in coaxial systems, Proceedings of the IEEE, 55, pp. 877-881.

557. Shekel, J. (1968), Measurement of structural return loss, Cablecasting, February.

558. Shekel, J. (1966), Color distortions in CATV systems, Cablecasting, June.

559. Simons, K. (1973), A shielding offectiveness measuring jig for CATV cables, Jerrold Electronics Corp., Horsham, Pa., unpublished paper available from author.

560. Simons, K. (1968), Technical handbook for CATV system, 3rd edition, Jerrold Electronic Corp., Philadelphia, Pa.

561. Siocos, C. (1968), Chrominance-to-luminance ratio and timing measurements in color television, IEEE Transactions on Broadcasting, March.

562. Siocos, C. (1966), Vertical interval test and reference signals (VITS) in the CBC television network, SMPTE Journal, 75, pp. 81-84.

563. Straus, T. (1974), The relationship between the NCTA, EIA, and CCIR definitions of signal-to-noise ratio, 23rd Annual NCTA Convention, Official Transcript, Technical Volume.

564. Switzer, I. (1972), An improved technique for measuring frequency, TV Communications, April.

565. Switzer, I. (1971), Spectrum analyzer applications in cable television, 20th Annual NCTA Convention, Official Transcript.

566. Switzer, I. (1971), An improved frequency measurement technique for CATV, 20th Annual NCTA Convention, Official Transcript.

567. Switzer, I. (1970), Techniques for calibration of signal level meters, TV Communications, January.

568. Switzer, I. (1969), Testing IF alignment with Heathkit marker generator, TV Communications, October.

569. Switzer, I. (1969), Test procedure and test equipment, 18th Annual NCTA Convention, Official Transcript.

570. Taggart, H. and J. Workman (1967), Calibration of FSM's, NBS Technical Note No. 370.

571. Taylor, A. (1971), Envelop delay -- the misunderstood phenomena of TV systems, IEEE Convention, March.

572. Taylor, A. (1966), Technical performance of community antenna television systems, IEEE Transactions on Broadcasting, BC-12 (1), p. 43.

573. Taylor, A. (1971), Performance characteristics of television receivers connected to cable television systems, Report to FCC for National Cable Television Association.

574. Taylor, A. and L. Janes (1970), Field testing the performance of a cable TV system, Proceedings of the IEEE, 58 (7).

575. Tektronix, Inc. (1969), Automated testing systems, 062-1106-00, Beaverton, Oregon.

576. Tektronix, Inc. (1968), Information display concepts, 062-1005-00, Beaverton, Oregon.

577. Tektronix, Inc. (1969), Probe measurements, 062-1120-00, Beaverton, Oregon.

578. Tektronix, Inc. (1969), Spectrum analyzer circuits, 062-1055-00, Beaverton, Oregon.

579. Tektronix, Inc. (1971), Spectrum analyzer measurements -- theory and practice, 062-1334-00, Beaverton, Oregon.

580. Tektronix, Inc. (1969), Television system measurements, 062-1064-00, Beaverton, Oregon.

581. Tektronix, Inc. (1970), Time-domain reflectometry measurements, 062-1244-00, Beaverton, Oregon.

582. Tenten, R. (1973), Practical methods of testing cable systems under present FCC rules, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

583. Thiele, A. (1966), Methods of waveform-pulse and bar-testing, Proceedings of the IREE (Australia), December.

584. Thompson, E. (1968), Measuring envelope delay in communication circuits for digital data links, Electronic Instrument Digest, July.

585. Townsley, R. (1969), Building a marker system for CATV sweep generators, TV Communications, December.

586. TV Communications (1969), CATV technical tip: terminating splices for cable testing, May.

587. Warren Braun Consulting Engineers (1972), Group delay measurements of AEL Communications Corp. RK-1 retrofit kit, Harrisonburg, Va., April 8.

588. Weaver, L. (1959), The measurement of random noise in the presence of a television signal, BBC Engineering Monographs, No. 24, March.

589. Welch, D. (1969), Spectrum analyzer measurements, Tektronix, Inc. 062-1070-00, Beaverton, Oregon.

590. Wolf, P. (1966), Modification of the pulse-and-bar test signal with special reference to application in color television, Journal of the SMPTE, 75, pp. 15-19.

## 3.7 Subscriber Terminals


591. Behrend, W. (1971), Performance comparison of TV transmitter RF demodulators and the home receiver, IEEE Transactions on Broadcasting, BC-17, (1).

592. Benson, B. (1973), Sources of variability in color reproduction as viewed on home receiver, IEEE Transactions on Broadcast and Television Receivers, November, pp. 269-276.

593. Bricker, G. and G. Hermeling (1973), A television receiver especially designed for CATV, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

594. Bridgett, A. (1974), Direct pickup won't go away by ignoring it, TV Communications, April.

595. Business Week (1972) A black box to replace the meter reader, February 12, pp. 70-71.

596. Capriglione, C., J. Davis, and E. Karcher (1971), Alpha-numeric character generator television display, Army Electronics Command, Fort Monmouth, New Jersey, NTIS AD-884595L.

597. Chalmers, E. (1974), Television receivers for CATV systems, IEEE Intercon Technical Papers, IEEE International Convention and Exposition, March.

598. Chamberlain, K. (1972), Multipurpose frame grabbing interactive experiments, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

599. Chuang, T. (1970), Multi-channel display and data communications, 19th Annual NCTA Convention, Official Transcript.

600. Coleman, M., K. Kinkelman, and W. Kolechta (1971), Alcoa picturephone remote information system, AFIPS Conference Proceedings, 39, pp. 65-70.

601. Court, P. (1969), Considerations in the design and use of CATV converters, 18th Annual NCTA Convention, Official Transcript, pp. 683-596.

602. Dean, E. (1960), Measurements of the subjective effects of interference in television reception, IRE, 48 (6), June.

603. Defense Documentation Center (1971), Color Television, Bibliography on color television display systems, August.

604. Eldridge, F. (1971), Uses for two-way polling: control terminals in cablecasting systems, MITRE Corporation WP-7584, May.

605. Ellsworth, P. (1972), Subscriber terminal interface requirements, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

606. Fink, D. (1943), Television standards and practices, McGraw-Hill Book Co., Inc., New York, New York.

607. Fink, D. (1957), Television engineering handbook, McGraw-Hill Book Co., Inc., New York, New York.

608. Fredendall, G. (1954), Delay equalization in color television, Proceedings of the IRE, 42 (1), pp. 258-262.

609. Fredendall, G. (1953), A comparison of monochrome and color television with reference to susceptibility to various types of interference, RCA Review, 14, September, p. 346.

610. Glasford, G. (1955), Fundamentals of television engineering, McGraw-Hill Book Co., Inc., New York, New York.

611. Goldmark, P. (1970), Color EVR, IEEE Spectrum, 58 (12).

612. Hamlin, P. (1969), Converters and television sets as CATV terminal devices, 18th Annual NCTA Convention, Official Transcript.

613. Hand, W. (1972), Television receiver requirements for CATV systems, IEEE Transactions on Broadcast and TV Receivers, BTR-18 (3), pp. 183-192.

614. Haskell, B., F. Mounts, and J. Candy (1972), Interframe coding of videotelephone pictures, Proceedings of the IEEE, 60 (7), pp. 792-800.

615. Hughes, W. and S. Campbell (1971), Some design considerations for home interactive terminals, IEEE Transactions on Broadcasting, BC-17 (2).

616. Lessman, A. (1971), Subjective effects of delay difference between luminance and chrominance information of the NTSC color television signal, J. of the SMPTE, 80, pp. 620-624.

617. Loughlin, B. (1973), Receiver and broadcast techniques, IEEE International Convention, Paper 39/1.

618. Lysek, M. (1974), The new status symbol for CATV subscribers, TV Communications, April.

619. McVoy, S. (1974), A low-cost two-way home terminal for CATV, Coaxial Scientific Corp., Sarasota, Florida.

620. Momberger, R. (1973), The frame grabber is a picture thief, TV Communications, January.

621. Nast, D. (1970), Picturephone transmission, IEEE International Convention Digest.

622. National Cable Television Association (1970), The TV receiver-CATV interface, 19th Annual NCTA Convention, Official Transcript, pp. 618-638.

623. Neal, B. (1973), Channel assignment plans; effect on receiver design, IEEE Transactions on Broadcast and Television Receivers, February, pp. 42-49.

624. Osborne, B. (1969), Color television reception and decoding technique, MacLaren, London and Hart, New York, New York, pp. 141-149.

625. RCA Review (1950), A study of co-channel and adjacent channel interference of television signals, 11, pp. 99-120.

626. Reiter, A. (1971), Ende-code television signal encoding and decoding for cable systems, 20th Annual NCTA Convention, Official Transcript.

627. Rhodes, C. (1969), Measurement of nonlinear distortions in NTSC color television, Proceedings of NAB Conference, pp. 218-228.

628. Rhodes, C. (1972), The 12.5T modulated sine-squared pulse for NTSC, IEEE Transactions on Broadcasting, BC-18 (1).

629. Roberts, L. (1972), Extensions of packet communication technology to a hand held personal terminal, AFIPS Conference Proceedings, 40, pp. 295-298.

630. Skinner, F. (1971), CATV set-top converters, MITRE Corp., M71-69, Washington, D.C., November.

631. Stetten, K. and W. Mason (1971), A low cost interactive home TV terminal, 20th Annual NCTA Convention, Official Transcript.

632. Switzer, I. (1971), The television receiver in the cable TV environment, IEEE Transactions on Broadcast and TV Receivers, 17 (3), pp. 133-140.

633. Vicom Manufacturing Company (1971), Interaction Television -- interaction terminals, Ann Arbor, Michigan, March.

634. Vincent, F. (1969), The converter's place in today's modern cable system, 18th Annual NCTA Convention, Official Transcript.

635. Walding, E. (1971), A second generation CATV converter, 20th Annual NCTA Convention, Official Transcript.

636. Walding, E. (1971), Spectrum pollution and the set top converter, TV Communications, July.

637. Wieder, B., R. Espeland, and C. Chilton (1973), Subscriber terminals and network interface, U.S. Dept. of Commerce, Office of Telecommunications Report, OTR 73-13, Vol. 2.

638. Wolff, R. and E. Breeze (1974), Novel Electronic TV touch tuning system using digital circuit techniques, IEEE Transactions on Broadcast and Television Receivers, Vol. BTR-20, No. 2, May.

639. Auerbach Computer Technology Reports (1971), Facsimile equipment, Auerbach Information, Inc., Washington, D.C.

640. Baker, C. (1968), Laser display technology, IEEE Spectrum, 56 (12), pp. 39-50.

641. Begovich, N. and L. Stokes (1970), A second generation AML, 19th Annual NCTA Convention, Official Transcript.

642. Behringer, R. (1971), AML microwave in local distribution service, presented at the Society of Cable Television Engineers, New York, July 29.

643. Bleisch, G. and W. Michaud (1971), A 6-channel bank putting new technologies to work, Bell Laboratories Record, 49 (8), pp. 251-254.

644. Broadcast Management-Engineering (1972), Local distribution service: AM or FM microwave or supertrunk?, August.

645. Candy, J., M. Franke, B. Haskell, and F. Mounts (1971), Transmitting television as clusters of frame-to-frame differences, BSTJ, July-August, 60 (6), pp. 1880-1917.

646. Clark, R. (1972), The domestic satellite characteristics and opportunities for cable TV, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

647. Cohen, M. and R. Daly (1971), An optical link for CATV, 20th Annual NCTA Convention, Official Transcript.

648. Community Antenna Television Journal (1974), Receiving ATS-6 satellite signals, August.

649. Cooper, G. (1970), A new look at microwave, TV Communications, November.

650. Cummings, D. (1970), Infrared and optical links for CATV, 19th Annual NCTA Convention, Official Transcript.

651. Davis, R. (1972), Multichannel microwaves for local distribution - AM or FM?, Microwaves, January.

652. Ellsworth, P. (1972), Subscriber terminal interface requirements, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

653. Evans, H. (1968), Technical background, AT&T domestic satellite proposal, AIAA 2nd Communication Satellite System Conference, paper 68-411, April.

654. Federal Communications Commission (1970), The economics of the TV - CATV interface, Staff Report to the FCC, Research Branch, Broadcast Bureau, July.

655. Feldman, N. (1969), Cable television and satellites, Rand Corp., Santa Monica, CA, NTIS N69-40175.

656. Gross, W. (1969), Domestic communications via satellite, WESCON Conc. Rec., session 12, paper 12-2, August.

657. Holman, R. (1970), Short-haul Microwave and the CATV industry, TV Communications, November.

658. Kessler, J. (1971), Fiber optics sharpens focus on laser communications, Electronics, July.

659. Kirk, D. and M. Paolini (1971), PCM subchannels for video microwave, 20th Annual NCTA Convention, Official Transcript.

660. Maccone, V. (1972), A single-sideband microwave local distribution system for CARS, Microwave Journal, April.

661. Marsten, R. (1972), The ATS-F satellite experiment with cable TV distribution, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

662. McClannan, Q. and G. Heckert (1970), A satellite system for CATV, Proceedings of IEEE, 58 (7).

663. McManamon, P. (1973), System interconnections, U.S. Department of Commerce, Office of Telecommunications Report, OTR 73-13, Volume 5.

664. National Cable Television Association (1972), A new network -- satellites, microwave, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

665. Neal, B. (1969), Television receiver and CATV system interface problems, 18th Annual NCTA Convention, Official Transcript.

666. Rao, B., K. Karnik, and V. Gupta (1972), Studies relating to television problems involved in satellite television broadcasting systems, AIAA 4th Communications Satellite Systems Conference, Washington, D.C., AUAA no. 72-524, A72-27353.

667. Rikelman, H. (1971), Optical Communications and the CATV industry, TV Communications, May.

668. Schlafly, H. (1974), Report on first U.S. domestic satellite receiver tests, IEEE Intercon Technical papers, IEEE International Convention and Exposition, March.

669. Sonnenschein, A. (1972), Performance of multi-channel microwave local distribution systems, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

670. Spearen, T. (1972), Multi-channel CARS band distribution using standard FM microwave equipment, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

671. Stetten, K. (1971), Interactive television software for cable television application, MITRE Report MTP-354, June.

672. Vogelman, J. (1971), Laser link revisited: FDM-FM CATV systems, Microwave System News, November-December, pp. 19-20.

673. American National Institute (1957), Definition of electrical terms, Troup 65, Communications, C42.65.

674. Baldwin, M. (1955), IRE standards on television: definitions of color terms, Proceedings of the IRE, 43 (6).

675. Bell, J. (1974), The development of proposed industry standards procedures for measuring TV receiver performance, IEEE Transactions on Broadcast and Television Receivers, BTR-20, No. 1, February.

676. Cable Technical Advisory Committee (CTAC) (1974), 1973 Annual Report, unpublished report to FCC, May.

677. Cable Technical Advisory Committee (CTAC) (1974), State governors' representatives conference -- transcribed remarks, April 16.

678. Cable Television Information Center (1973), Technical standards and specifications: ordinance supplement section VII, The Urban Institute, Washington, D.C.

679. Canadian Department of Communications (1973), Proof of performance procedure for cable television (CATV) systems, Broadcast Procedure 24, Issue 1, final draft, January.

680. Canadian Department of Communications (1972), Technical standards and procedures for cable television systems with augmented channel capacity, Broadcast Procedure 23, Issue 1, release date June 28.

681. Canadian Department of Communications (1971), Technical standards and procedures for cable television (CATV) systems, Broadcast Procedure 23, Issue 1, release date March 29.

682. Canadian Department of Commerce (1971), Notes on DOC program for implementation of technical standards for cable television systems, March.

683. Chadwick, R., R. Gallawa, and L. Wood (1973), Signal transmission and delivery between head-end and

subscriber terminals, U.S. Dept. of Commerce, Office of Telecommunication Report, OTR 73-13, Volume 3.

684. Chipp, R. (1966), CATV technical standards, IEEE Transactions on Broadcasting, BC-12, (1).

685. Easton, K. (1972), Technical standards -- FCC & DOC agree, or disagree, TV Communications, June.

686. Electronic Industries Association (1974), Technical standards for a cable compatible television receiver and related cable systems, proposed EIA engineering bulletin, May 28.

687. Electronic Industries Association (1973), The index of EIA and JEDEC standards and engineering publications, with revision #2 and 1974 addendum.

688. Electronic Industries Association (1958), EIA standard, RS-207, Television tuner performance presentation and measurements.

689. Electronic Industries Association (1965), EIA standard, RS-232B, EIA Engineering Department, Washington, D.C.

690. Electronic Industries Association (1961), EIA standard, RS-240, Electrical performance standards for television broadcast transmitters.

691. Electronic Industries Association (1966), EIA standard, RS-330, Electrical performance standards for closed circuit television camera 525/60 interlaced 2:1.

692. Electronic Industries Association (1967), EIA standard, RS-250A, Electrical performance standards for television relay facilities.

693. Electronic Industries Association (1967), EIA standard, RS-341, Standard of good engineering practice regarding the antenna input impedance of a television receiver.

694. Electronic Industries Association (1972), EIA standard, RS-252A, Standard microwave transmission systems.

695. Electronic Industries Association (1954), RETMA standard, REC-140, Good engineering practice regarding I.F. rejection of television receivers.

696. Federal Communications Commission (1972), Cable television report and order, 36 FCC 2d 199.

697. Federal Communications Commission (1972), Reconsideration of cable television report and order, 36 FCC 2d 359.

698. Federal Communications Commission, Rules and regulations, Part 73, Subpart E, and Part 76.

699. Federal Communications Commission (1972), Cable Technical Advisory Committee statement of policies and operations.

700. Head, H. (1972), The FCC's new technical standards, Broadcast Engineering, 14 (4).

701. Hickman, E. (1968), Relaying equipment specifications to system specifications, TV Communications, October.

702. International Electrotechnical Commission (1974), Draft -- measurement of external immunity of a television receiver to radiated interference at the tuned frequency, June.

703. IRE (1954), NTSC color system, Proceedings of the IRE, Vol. 42, No. 17, entire issue.

704. Kleykamp, G. (1969), Relating NCTA equipment specifications to CATV system design, TV Communications, January.

705. Lines, S. (1972), Cable television technical standards -- concepts and interpretations, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

706. Malarkey, Taylor, and Associates (1970), Cable TV system proposal for Tulsa and performance specifications, September.

707. Michigan CATV Associates (1972), Cable television working agreement with GTE Sylvania, Inc.

708. National Cable Television Association (1974), Comments of NCTA on FCC notice of inquiry on federal preemption of technical standards, August 2.

709. National Cable Television Association (1974), Reply comments on FCC notice of inquiry on federal preemption of technical standards, August 20.

710. National Cable Television Association (1973), The Relationship between federal/state/municipal control in technical standards, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

711. National Cable Television Association (1970), Standard on visual carrier level, NCTA No. 001B-0670.

712. National Cable Television Association (1969), Standard on noise level in cable systems, NCTA No. 005-0669.

713. National Cable Television Association (1968), Standard on graphic symbols, NCTA No. 003-0668.

714. National Cable Television Association (1967), Standard on amplifier distortion, NCTA No. 002-0267.

715. Penwell, N. (1972), Critical steps to compliance, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

716. Stetka, F. and M. Brandon (1959), NFPA Handbook of the National Electrical Code, McGraw-Hill Book Company, New York, N. Y.

717. Taylor, A. (1966), Technical performance of community antenna television systems, IEEE Transactions on Broadcasting, BC-12 (1), 43.

718. Television Allocations Study Organization (TASO), (1959), Engineering aspects of television allocations, Report to Federal Communications Commission, March.

719. Town, G. (1960), The television allocation study organizations and accomplishments, Proceedings of the IRE, 48 (6).

720. U.S. Air Force (1972), Standards for CATV systems, August 2, AFR 70-3.

721. U.S. Department of Commerce, National Bureau of Standards, List of publications in the federal information processing standards series, with addendum, NBS LP 58, revised July, 1972.

722. Walker, A. P. (1960), NAB engineering handbook, Part 3: Electrical performance standards for television relay facilities, A proposed EIA standard, 5th edition, McGraw-Hill Book Company, New York, N. Y.

723. Wydro, W. (1969), CATV picture performance standards, 18th Annual NCTA Convention, Official Transcript.

## 3.10 Computers and CATV


724. Baird, J. (1970), An optical data link for remote computer terminals, Datamation, 16 (1), pp. 125-126.

725. Billows, C. (1970), Information retrieval: an experimental system, TV Communications, March.

726. Bitzer, D. and D. Skaperdas (1969), The design of an economically viable large-scale computer based education system, Computer-based Education Research Laboratory, University of Illinois, February.

727. Bushnell, D. and D. Allen (1967), The computer in American education, commissioned by the Association for Educational Data Systems, John Wiley and Sons, Inc., New York.

728. Campbell, L. (1973), The use of computers in CATV two-way communication systems, U.S. Department of Commerce, Office of Telecommunications Report, OTR 73-13, Volume 6.

729. Cauldwell, J. (1973), Computer controlled CATV system, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

730. Crawford, T. (1973), An analysis of system planning, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

731. Ferrell, C. and P. Knolse (no date available), The impact of satellite communications on computer networks, Computers and Communications Conference.

732. Fife, D. (1968), Alternatives in evaluation of computer systems, MITRE Report MTR-413.

733. Greenberger, M. (ed.) (1971), Computers, communications, and the public interest, the Johns Hopkins Press, Baltimore, Md.

734. Hillegass, J. (1972), The minicomputer -- getting it all together, Computer Decisions, pp. 34-50.

735. Hoffman, L. and W. Millar (1970), Getting a personal dossier from a statistical data bank, Datamation, 16, pp. 74-75.

736. Kay, I. (1972), Discrete simulation languages, AFIPS Conference Proceedings.

737. Martin, J. (1967), Design of real-time computer systems, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

738. Mason, W. and S. Polk (1972), Revolutionizing home communications -- new techniques for using computers with cable television, M72-38, The MITRE Corporation, March.

739. Mathews, R. (1972), Computer service: converging on cable, TV Communications, January.

740. Mathews, R. (1971), Computerized records for modern management, TV Communications, January.

741. Ossanna, J. (1972), The current state of minicomputer software, Proceedings of the AFIPS Conference, 40.

742. Ramasco, J. (1971), Whether two-way systems transmit over one or two cables, they'll do best when linked to computers, Electronics, 44 (20).

743. Roberts, L. and B. Wessler (1970, Computer network development to achieve resource sharing, Proceedings of the AFIPS Conference, 36.

744. Rodriguez, E. (1971), Computer support for an experimental picturephone computer system at BTL, Proceedings of the AFIPS Conference, 39.

745. Rosenfeld, A. (1971), Picture processing by computers, Academic Press, New York.

746. Sharpe, W. (1969), The economics of computers, R-463-PR, The Rand Corporation, August.

747. Stetten, K. (1971), Interactive television software for cable television application, the MITRE Corporation, MTD-354.

748. Stetten, K., R. Morton, and R. Mayer (1970), The design and testing of a cost effective computer system for CAI-CMI application, the MITRE Corporation, M69-39, April.

749. Stimler, S. (1969), Real time data processing systems, McGraw-Hill Book Company, New York, N. Y.

750. Switzer, I. (1972), The cable television system as a computer network, TV Communications, July.

751. Telecommunications (1972), The communications minicomputers, October, pp. 15-22.

752. Thompson, W. (1973), Programmable calculations as an aid in system design, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

753. Turner, H. (1972), A computer system for microwave frequency coordination and interference calculations, IEEE Transactions on Communications, COM-20 (2).

754. Tymes, L. (1971), TYMNET -- a terminal oriented communication network, AFIPS Conference Proceedings, 38, pp. 211-216.

755. Waks, D. and A. Kronenberg (1972), The future of mini-computer programming, Proceedings of the AFIPS Conference, 40, pp. 103-109.

756. Watson, R. (1970), Timesharing system design concepts, McGraw-Hill Book Company, New York, N. Y.

757. Atkinson, D. (1975), The impact of advanced telecommunication services on the structure of the local distribution networks, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

758. Baran, P. (1974), Interactive television for compensatory training of culturally deprived preschool children, the Rand Corporation.

759. Becker, D. and G. Willibald (1975), Classification and assessment of telecommunication services in broadband networks, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

760. Benton, C., W. Howell, H. Oppenheimer, and H. Urrows (1969), Television in urban education, Praeger, New York, N. Y.

761. Billowes, C. (1971), On-demand educational television program retrieval system for schools, Proceedings of the IEEE, 59 (6).

762. Bird, K. (1969), Telediagnosis: A new community health resource, Educational and Instructional Broadcasting, February.

763. Braun, W. and D. Walker (1970), Vehicular location and information systems, IEEE Transactions on Vehicular Technology, VT-19 (1).

764. Bretz, R. (1969), Television and ghetto education: the Chicago schools approach, the Rand Corporation, P-4108, June.

765. Burns, R. (1971), The educator and CATV: possibilities for partnership, 20th Annual NCTA Convention, Official Transcript.

766. Dickinson, R. (1973), Commercial data transmission over a cable television system, 22nd NCTA Convention, Official Transcript, Technical Volume.

767. Dickinson, R. (1973), A second look at commercial data communications in New York City, Consultant to Sterling Manhattan Cable Television Inc., New York, N.Y.

768. Dordick, H. (1968), Adult Education Goals for Los Angeles, A working paper for the Los Angeles goals program, the Rand Corporation, P-3808, March.

769. Eldridge, F. (1972), Privacy for cable services, the MITRE Corporation, M72-59.

770. Eldridge, F. (1971), System for automatic reading of utility meters, the MITRE Corporation, M72-7.

771. Eldridge, F. (1972), Automatic meter reading via cable, the MITRE Corporation, M72-67.

772. Gabriel, R. (1972), Two-way experience with dial-a-program at Dennis Port, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

773. Gazis, D. (1971), Traffic Control: From hand signals to computers, Proceedings of the IEEE, 59 (7).

774. General Electric Company (1968), A study of command and control systems for urban transportation, U.S. Department of Commerce Clearinghouse, PB-178-281.

775. Gould, A. (1970), Automatic vehicle monitoring, EASCON.

776. Greene, J. (1970), CATV and its implications for instructional television in the District of Columbia, Testimony before the Manpower and Economic Development Committee of the D.C. City Council, November 13.

777. Gross, W. (1970), Distribution of electronic mail over the broad-band party-line communications network, Proceedings of the IEEE, 58 (7).

778. GTE Laboratories, Inc. (1971), Proposal for an experiment in communications-electronics services for St. Charles Communities, Maryland.

779. Howell, W. (1972), Document reporting the recommendations and suggestions of the Dayton Seminar on cable communications for publis service, Dayton, Ohio.

780. Hughes Aircraft Company (1970), Design study and master plan for an improved command control communications system serving the emergency service departments of the City of Los Angeles.

781. IBM (1966), San Jose traffic control project -- Final report, IBM Corp. Data Processing Report, San Jose, California.

782. Jet Propulsion Laboratory (1970), Interim report on private alarm signaling systems, Space Technology Applications, Task 126, National Aeronautics and Space Administration, Washington, D.C.

783. Jones, W. Jr., S. Riter, and R. Hambrick (1975), Telecommunications in urban public services, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

784. Jordan, P. (1971), Instructional uses of cable television in Washington, D.C., WN-7515-ff, Working Draft, the Rand Corporation, Santa Monica, California.

785. Kilham, L. (1970), New communications technology for planned development of Connecticut, Connecticut Research Commission, Hartford, Connecticut.

786. Ledbetter, T. (1971), CATV and the cities (problems and promises), 20th Annual NCTA Convention, Official Transcript.

787. Macy, J. (1971), Community uses of public television, City, 5, pp. 23-25.

788. Mason, W. and S. Polk (1972), Revolutionizing home communications, the MITRE Corporation, M72-38.

789. McCormick, E. (1972), Cable television: a community information system at Jonathan, 21st Annual NCTA Convention, Official Transcript, Technical Volume.

790. McManamon, P. (1975), Technical implications of a teleconference service, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

791. Metcalf, R. (1971), CATV and the cities (problems and promises), 20th Annual NCTA Convention, Official Transcript.

792. Moeller, J. (1971), CATV ancillary services, 20th Annual NCTA Convention, Official Transcript.

793. National Academy of Engineering (1969), Educational technology in higher education: the promises and limitations of ITV and CAI, Commission on Education, September.

794. National Academy of Engineering (1969), Telecommunications for enhanced metropolitan function and form, Committee on Telecommunications, Washington, D.C.

795. Pearson, H. (1974), Public access -- community response, IEEE Intercon Technical Papers, IEEE International Convention and Exposition, March.

796. Raynor, H. Jr. (1969), Charleston's computerized traffic control system, Traffic Engineering and Control, May.

797. Rockoff, M. (1975), An overview of some technological/health care system implications of seven exploratory broadband communication experiments in health services delivery, IEEE Transactions on Communications, Special Issue on Interactive Broadband Cable Systems, January.

798. Roth, S. and R. Noyer (1970), Automatic vehicle monitoring and control in an urban environment, the American Society of Mechanical Engineers, New York, N.Y., 70-TRAN-40.

799. Schlafly, H. (1971), A cable caster discusses what services can be obtained from different two-way systems, Electronics, 44 (20).

800. Stetten, K. (1971), Interactive television software for cable television applications, the MITRE Corporation, MTP-354.

801. Stetten, K. (1971), The technology of small local facilities for instructional use, MITRE Report MTP-347, January.

802. Stetten, K. (1972), A study of the technical and economic considerations attendant on the home delivery of instruction and other socially-related services via interactive Cable TV, MITRE Report M72-200, December.

803. Tate, C. (ed.) (1971), Cable television in the cities: community control, public access, and minority ownership, Washington, D.C., the Urban Institute.

804. TV Communications (1972), Sterling Manhattan: serving the multitude, Vol. 9, January.

805. Ulicki, E. (1973), Security surveillance for offices, institutions, hotels, and apartments using existing cabling, IEEE Electronic Security Systems Seminar, pp. 20-27.

806. Vicom Manufacturing Company (1971), Interaction television, services to subscribers, Ann Arbor, Michigan, March.

807. Wallerstein, E., C. Marshall, and R. Alexander (1973), Pediatrics and cable television, 22nd Annual NCTA Convention, Official Transcript, Technical Volume.

FORM OT-29
(3-73)

U.S. DEPARTMENT OF COMMERCE
OFFICE OF TELECOMMUNICATIONS

# BIBLIOGRAPHIC DATA SHEET

| | 1. PUBLICATION OR REPORT NO. | 2. Gov't Accession No. | 3. Recipient's Accession No. |
|---|---|---|---|
| | | | |

**4. TITLE AND SUBTITLE**
A GUIDE TO TECHNICAL STANDARDS AND MEASUREMENTS FOR CABLE TELEVISION SYSTEMS

**5. Publication Date**

**6. Performing Organization Code**

**7. AUTHOR(S)**
William C. Hsiao

**8. PERFORMING ORGANIZATION NAME AND ADDRESS**
Telecommunications Analysis Division
Office of Telecommunications
U. S. Department of Commerce
Washington, D.C. 20230

**9. Project/Task/Work Unit No.**

**10. Contract/Grant No.**
NSF Grant No.
SSH74-24664 (in part)

**11. Sponsoring Organization Name and Address**

**12. Type of Report and Period Covered**

**13.**

**14. SUPPLEMENTARY NOTES**

**15. ABSTRACT** *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*


The preparation of this report was supported in part by Grant No. SSH74-24664 from the National Science Foundation. The National Science Foundation awarded seven grants under Phase I of the program, "Design Studies for Experimental Application of Two-Way Cable Communications to Urban Social Service Delivery and Administration." The seven grantees provided to the Foundation on January 6, 1975, detailed final proposals for the execution of appropriate experiments in broadband communications. Under the NSF grant to the Office of Telecommunications, OT provided to the Foundation and the seven Phase I grantees technical advisory services, including draft versions of Sections 1 and 3 of this report, to assure that the seven grantees had access to up-to-date technical information needed to adequately formulate and support their Phase II proposals.

Section 1 of the report discusses CATV system technical requirements and lists referenced specifications, CATV system design criteria, system performance guidelines, and system construction specifications. Section 2 consists of ten measurement chapters which discuss test procedures applicable to measurement and evaluation of technical performance of CATV systems to assure compliance with the Federal Communications Commission's Rules and Regulations. Section 3 of the report is a bibliography of technical literature concerned with cable television systems. The references have been organized into ten subject areas listed in the Table of Contents and consist of 807 entries.


**16. KEY WORDS** (alphabetical order, separated by semicolons)
Bibliography; Cable television; Design criteria; FCC; Performance guidelines; Specifications; Technical requirements

| 17. AVAILABILITY STATEMENT | 18. Security Class *(This report)* | 20. Number of pages |
|---|---|---|
| ☐ UNLIMITED. | Nonclassified | 131 |
| ☐ FOR OFFICIAL DISTRIBUTION. | 19. Security Class *(This page)* | 21. Price: |



USCOMM-DC 29716-P73

☆ U.S. GOVERNMENT PRINTING OFFICE: 1976— 210-801/342